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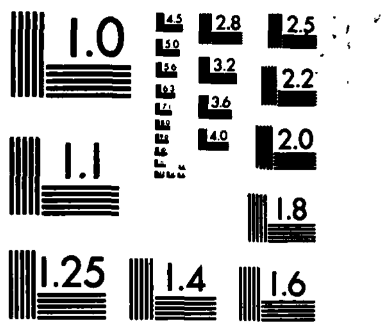

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NSWC TR 83-428

IN INVISCID COMPUTATIONAL METHOD FOR SUPERSONIC INLETS

BY A. B. WARDLAW, JR., DAVID SHUMWAY, FRANK BALTAKIS

RESEARCH AND TECHNOLOGY DEPARTMENT

22 MARCH 1984

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An extension to the SWINT code is described which permits inviscid calculations to be performed on the supersonic portion of inlet flow fields. Also described is an interface program which rezones the external flow field applied to several examples. A listing of the extension to SWINT and the interface program are provided in the Appendices along with a set of user instructions and a sample case.

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INTRODUCTION

This report describes a computational method for calculating supersonic inviscid flow within an inlet using an extension of the SWINT code which is described in References 1, 2 and 3. The SWINT code is designed to calculate 3-D external supersonic flow fields on a missile type configuration. It marches a known nosetip flow field down the length of the missile body. The computational domain is bounded on the inside by the body surface and on the outside by the bow shock which is tracked. It is restricted to flow fields which are supersonic everywhere and is specifically designed to treat thin lifting surfaces. The points interior to the computational domain are described using a weak conservation form of the Euler equations while a characteristic analysis is applied to determine the relations applicable at the body fin or shock. The MacCormack explicit method is used to advance the flow field.

The modifications to SWINT described in this report primarily consist of replacing the shock relations with solid wall conditions. The computational domain is now bounded along the lower and upper edges by the body and cowl respectively. The inlet computation is started using the flow field at the inlet face determined by the SWINT code. This flow field is re-grid at the inlet face to exclude portions of the flow field outside the cowl using the interface program COWLI which is also described in this report.

The extended SWINT code is only applicable to the supersonic portion of the inlet and fails when the axial Mach number becomes less than unity. Internal shocks are not tracked but instead captured by the numerical scheme. The modified SWINT code is most applicable to cylindrical inlets (not necessarily circular) since the left and right edges of the computational domain are treated using either a symmetry or antisymmetry condition

implemented in cylindrical coordinates. However, reflection boundary conditions may be used to simulate planar walls that are aligned with the body axis. This makes it possible, in principle, to treat certain non-cyclindrical cases. Planar flows can also be approximated by using large body and cowl radii.

In the remainder of this report the extension of SWINT to handle inlets is outlined and several test cases are presented. The interface program, COWLI, is also described. This program calculates induced inlet drag, recovery pressure and mass capture as well as rezoning the inlet face flow field. Appendices A, B and C present a listing of COWLI, an update deck listing for converting the original SWINT to the extended version described in this report, and user instructions for applying SWINT. A sample inlet run is provided in Appendix D.

MODIFICATIONS TO THE SWINT CODE

COWL BOUNDARY CONDITIONS

The major modification of SWINT involves implementation of surface boundary conditions at the outer edge of the computational domain. This development parallels that for the body surface which is outlined in References 1-3 and given in detail in Reference 4. For completeness the results and analysis are summarized here. The physical and computational coordinates applicable to an inlet configuration are shown in Figures 1 and 2 respectively.

On the cowl surface ($X = 1$) the normal velocity component is zero which implies:

$$u - \tilde{c}_z w - (\tilde{c}_\phi/\tilde{c})\ v = 0 \qquad (1)$$

This condition is supplemented with certain characteristic compatibility relations associated with the Euler equations. It is found that there are three independent characteristic relations which are admissible on $X = 1$. These can be written as a system of quasi-linear first order partial differential equations on $X = 1$ for advancing $P = \ln(p)$, $V_4 = u(\tilde{c}_\phi/\tilde{c}) + v$ and s. The resulting relations are

$$\frac{\partial P}{\partial Z} = \left[X_r\lambda_- \frac{\partial p}{\partial X} - \frac{1}{\beta_1}\{\rho w[\ \lambda_- \frac{\partial A}{\partial X} - (a_7 w + a_4 v)] + \hat{p}\}\right] \frac{1}{p} \qquad (2a)$$

where $$\hat{p} = \frac{\rho v}{\tilde{c}} V_4 + w\lambda_- e_1 + \xi \cdot \frac{\partial G}{\partial Y}$$

$$(2b)$$

$$+ p[\xi_2(T_{g_5}Y_z + T_{g_6}) + \frac{1}{\tilde{c}}\xi_4\ (T_{g_5}Y_\phi + \tilde{c}_\phi/\tilde{c})]$$

$$\lambda_- = \frac{a^2\ (\beta_1 - \tilde{c}_z)}{w^2 - a^2},\ \beta_1 = -\sqrt{\frac{w^2}{a^2}\quad \nu_\omega^2 - [1 + (\frac{\tilde{c}_\phi}{\tilde{c}})^2]}$$

$$a_7 = \frac{\partial \tilde{c}_z}{\partial Z} = \tilde{c}_{zz} - \tilde{c}_{z\phi} Y_z / Y_\phi$$

$$a_4 = \frac{\partial(\tilde{c}_\phi / \tilde{c})}{\partial Z} = \frac{1}{\tilde{c}}[\tilde{c}_{z\phi} - \frac{\tilde{c}_z \tilde{c}_\phi}{\tilde{c}} - (\tilde{c}_{\phi\phi} - \tilde{c}_\phi^2/\tilde{c}\ ) Y_z / Y_\phi]$$

$$\vec{\xi} = (\xi_1, \xi_2, \xi_3, \xi_4)$$

$$\xi_1 = w\lambda_-(2 - V^2 \kappa_1/\rho)\ ,\ \xi_2 = \tilde{c}_z - \lambda_- + w^2 \kappa_1 \lambda_-/\rho$$

$$\xi_3 = wu\kappa_1 \lambda_-/\rho - 1\ ,\ \xi_4 = wv\kappa_1 \lambda_-/\rho + \tilde{c}_\phi/\tilde{c}$$

$$\kappa_1 = (\frac{\partial \rho}{\partial h})_p = 1/(\frac{\partial h}{\partial \rho})_p \quad (\kappa_1 = -\rho/h \text{ for a perfect gas})$$

$$T_{g_5} = g_{YY}/g_Y \quad ,\quad T_{g_6} = g_{ZY}/g_Y \quad ,\ \hat{G} = GJ/r$$

$$\nu_\omega^2 = 1 + (\tilde{c}_\phi/\tilde{c})^2 + \tilde{c}_z^2$$

$$A = X_r u + \frac{X\phi}{r} v + X_z w$$

$$\frac{\partial V_4}{\partial Z} = a_4 u + \hat{\nu}/\rho w \qquad (3a)$$

where

$$\hat{\nu} = \vec{\eta} \cdot \frac{\partial \hat{G}}{\partial Y} - \rho v w\ \tilde{c}_z/\tilde{c} - p(T_{g_5} Y_\phi + \tilde{c}_\phi/\tilde{c})/\tilde{c} \qquad (3b)$$

$$\vec{n} = (n_1, n_2, n_3, n_4)$$

$$n_1 = V_4 \quad , \quad n_2 = 0 \; , \; n_3 = -\tilde{c}_\phi/\tilde{c} \; , \; n_4 = -1$$

$$\frac{\partial s}{\partial Z} = -\frac{B}{w}\frac{\partial s}{\partial Y}$$

where $B = \frac{Y\phi v}{r} + Y_z w$

Alternative expressions for $\hat{p}$ and ν of (2b) and (3b) which often give improved results are:

$$\hat{p} = \frac{\rho v}{\tilde{c}} V_4 + [\tilde{c}_z Y_z + \frac{1}{\tilde{c}^2}\tilde{c}_\phi Y_\phi + (\frac{Bw}{a^2} - Y_z)\lambda_-]\frac{\partial p}{\partial Y} \qquad (2c)$$

$$- \rho B\,(a_5 w + a_3 v)$$

$$+ \rho w \lambda_- \{(T_{f_6} - T_{g_6})\, w + \frac{v}{\tilde{c}} T_{f_7} + \frac{w}{\tilde{c}}[Y_\phi \frac{\partial (v/w)}{\partial Y} + \tilde{c}_z]\}$$

where

$$a_5 = \frac{\partial \tilde{c}_z}{\partial Y} = \tilde{c}_{z\phi}/Y_\phi$$

$$a_3 = \frac{\partial\,(\tilde{c}_\phi/\tilde{c})}{\partial\, Y} = [\tilde{c}_{\phi\phi}/\tilde{c} - (\tilde{c}_\phi/\tilde{c})^2]Y_\phi$$

$$T_{f_6} = T_{g_6} + \frac{f_{ZX} + Y_z f_{YX}}{f_X} - \frac{(b_z - \tilde{c}_z)}{(\tilde{c} - b)}; \; T_{f_7} = \frac{Y_\phi f_{YX}}{f_X} + \frac{(\tilde{c}_\phi - b_\phi)}{(\tilde{c} - b)}$$

and

$$\hat{\nu} = \rho\, B(a_3 u - \frac{\partial V_4}{\partial Y}) - \frac{1}{\tilde{c}} Y_\phi \frac{\partial p}{\partial Y} - \frac{\rho v w}{\tilde{c}}\tilde{c}_z \qquad (3c)$$

Many configurations of interest have sharp corners or edges such as those found on biconics and other segmented shapes. If the upstream cowl surface velocity normal to this edge is supersonic, either a shock wave or an expansion fan will be attached to it producing a discontinuity in the surface flow variables. To handle this situation, an oblique shock or Prandtly-Meyer expansion is applied at the edge as is described in References 1 to 4. In the interior these discontinuities are captured using the dissipative and conservation properties of the interior point scheme. Analogous procedures are applied on the body and fin surfaces.

COWL INTERFACE PROGRAM

The cowl interface program operates on the inlet face flow field generated by an external SWINT run. It is designed for cylindrical, but not necessarily circular, inlets and rezones the flow field to lie within the inlet. In addition, this program calculates recovery pressure throughout the inlet plane, average recovery pressure for the inlet plane and the flow entering the inlet, mass captured by the inlet and induced forces. A listing of this routine is provided in Appendix A and user instructions are outlined in Appendix C.

The average inlet plane recovery pressure ratio, average inlet recovery pressure ratio and the mass captured by the inlet are determined from Equations (4a), (4b) and (4c) respectively:

$$(p_t/p_{t\infty})_{\substack{\text{Inlet}\\ \text{Plane}}} = \frac{1}{Pt_\infty A_p} \int_0^{2\pi} \int_b^{\tilde{c}} p \left[1 + \frac{(\gamma-1)}{2} M^2\right]^{\gamma/(\gamma-1)} r\,dr\,d\phi \qquad (4a)$$

$$(p_t/p_{t\infty})_{\text{Inlet}} = \frac{1}{Pt_\infty A_I} \int_0^{\overline{2\pi}} \int_b^{\tilde{c}} p \left[1 + \frac{(\gamma-1)}{2} M^2\right]^{\gamma/(\gamma-1)} r\,dr\,d\phi \qquad (4b)$$

$$m = \int_0^{2\pi} \int_b^{\tilde{c}} \rho w r\,dr\,d\phi \qquad (4c)$$

where:

$$A_I = \int_{o}^{2\pi} \int_{b}^{\tilde{c}} rdrd\phi, \quad A_p = \int_{o}^{2\pi} \int_{b}^{c} rdrd\phi$$

The induced forces are those produced by the action of pressure on the stream surface which intersects the cowl lip. They can be directly determined by storing the flow field upstream of the inlet face and tracking the stream surface intersecting the cowl lip back through the flow field until it intersects the bow shock. With the geometry of this stream surface known, the surface pressure along it can be integrated to produce induced drag and lift. For complicated bodies at incidence, the stream surface intersecting the cowl may exhibit a very complex shape and this type of procedure is both laborious and difficult to implement. An alternative approach is to balance forces and moments acting in the control volume illustrated in Figure 3. Here the induced forces are determined by performing integrations at the inlet face plane. The resulting equations for axial, normal and yaw force are:

$$F_a = \int_{o}^{2\pi} \int_{\tilde{c}}^{c} [\rho w(w_\infty - w) + \frac{\rho_w p_\infty}{\rho_\infty w_\infty} - p] \; rdrd\phi \tag{5a}$$

$$F_n = \int_{o}^{2\pi} \int_{\tilde{c}}^{c} \rho w \; [\tilde{u}_\infty - \tilde{u}] \; rdrd\phi \tag{5b}$$

$$F_y = \int_{0}^{2\pi} \int_{\tilde{c}}^{c} \rho w \, [\tilde{v}_{\infty} - \tilde{v}] \, r dr d\phi \qquad (5c)$$

where $\tilde{u} = - \cos\phi u + \sin\phi v$

$\tilde{v} = \sin\phi u + \cos\phi v$

Figure 4 indicates the sign convention for these forces. Although this procedure is much simpler than the first approach described, the results must be carefully scrutinized. There may be cases where the values of the integrands in (5) are the small differences between two large numbers. Both approaches have been tested on sample axisymmetric cases and results agree within several percent. An additional check on the accuracy of this procedure can be accomplished by comparing the force coefficients calculated by SWINT with those of equation (5). Here the SWINT calculated force coefficients correspond to those acting on the portion of the body forward of the inlet plane, and equations (5) are integrated from the body to the shock. To adjust for the assumption used in SWINT that the based pressure is p_{∞} , A^{*}/q_{∞} must be added to the drag force coefficient calculated by SWINT. Here A* is the center body cross-sectional area at the inlet plane. The drag force coefficients computed by these two different techniques generally agree to within 2%. Discrepancies between the SWINT calculated normal and yaw force and the results from (5b) and (5c) are greater, with errors of approximately 15% and 5% occuring on a cone at 5° incidence at Mach 2 and Mach 4 respectively. In order to provide a guide to the accuracy of the calculated induced forces, the interface program COWLI computes this comparison for each force component.

RESULTS

The extended SWINT code has been applied to a number of different configurations, three of which are illustrated in this section. In each case, measured surface pressures are compared to calculated values. The computations were carried out using 19 points between the body and the cowl. In the axisymmetric cases three circumferential planes were used, while in the other situations this number was increased to 13. The tested inlets were of the mixed compression, asymmetric type with a translating center-body. All cases feature boundary layer bleed and/or slots to reduce the thickness of the boundary layer.

The first inlet considered is described in Reference 5 and results, along with a sketch of the inlet, are shown in Figure 5. This example features a free-stream Mach number of 2.3, 0° incidence, boundary layer bleed and a center body scoop upstream of the throat. The geometry was approximated using a piece-wise continuous function generated from a tabular listing of the centerbody and cowl profiles which was provided in Reference 6. Derivatives were approximated using a central differencing of the surface locations evaluated with the local computation step size, $\pm\Delta z$. The scoop upstream of the throat was simulated using the inlet option of SWINT which excludes from the calculation that portion of the flow field entering the scoop.

Figure 6 illustrates a comparison between SWINT results and those measured in Reference 6. This inlet, which is depicted in Figure 6, features wall bleed, a free-stream Mach number of 2.5, and an incidence of 0°. The body and cowl geometries are described using the cubic splines provided in Reference 6.

The final case considered is illustrated in Figure 7 and features an inlet at Mach 3.3 and incidence of 3°. The experimental data used for comparison was generated in Reference 7 and reported in References 7 and 8. Results from the leeward and windward planes are compared with experiment. The geometry description was generated from a tabular listing of the body and cowl profiles. Central differencing was again used to generate needed body and cowl derivatives.

The results shown in Figures 6, 7 and 8 are in reasonable agreement with experiment. However, the predicted location at which shocks strike the centerbody or cowl is downstream of the measured one. This is to be expected since the effective distance between the centerbody and the cowl is decreased by the presence of the boundary layer.

In some of the calculated cases, it is possible to march through the diffuser to the end of the inlet without encountering subsonic flow. In cases where the throat Mach number is greater than unity, the exit conditions determine the location of the terminal shock and, hence, subsonic regions in the inlet. The marching method currently employed precludes application of the downstream boundary conditions, and the resulting solution represents exit conditions with sufficiently low pressure to permit supersonic flow throughout the inlet.

CONCLUDING REMARKS

The SWINT code has been extended to allow inviscid calculations to be performed on the supersonic portions of inlets. This procedure replaces the bow shock tracking procedure with solid surface boundary conditions. In addition, an interface program has been developed which rezones the external flow field upstream of the inlet face to include only that portion of the flow field entering the inlet. The interface program also calculates forces, mass captured by the inlet and average recovery pressure for the flow entering the inlet. The external flow field upstream of the inlet can be determined with either the original version of SWINT or the extended version described in this report. The extended SWINT code is best suited for calculating cylindrical inlets (not necessarily circular) and is restricted to geometries where the inlet lip lies in a plane perpendicular to the missile axis. Comparisons between calculation and experiment have been performed for several axisymmetric, external compression inlets with boundary layer bleed. Computed surface pressures are in reasonable agreement with experiment.

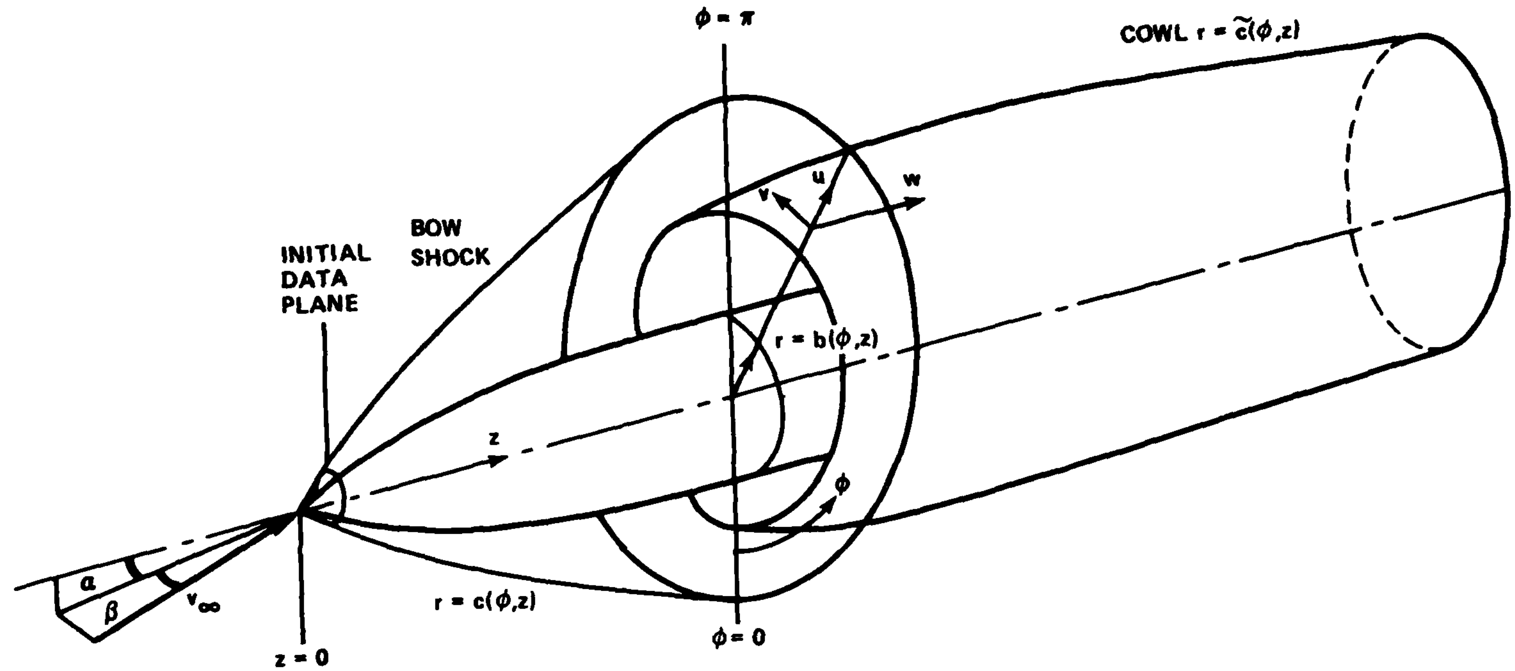


FIGURE 1. CYLINDRICAL COORDINATE SYSTEM USED FOR INVISCID FLOW CALCULATIONS

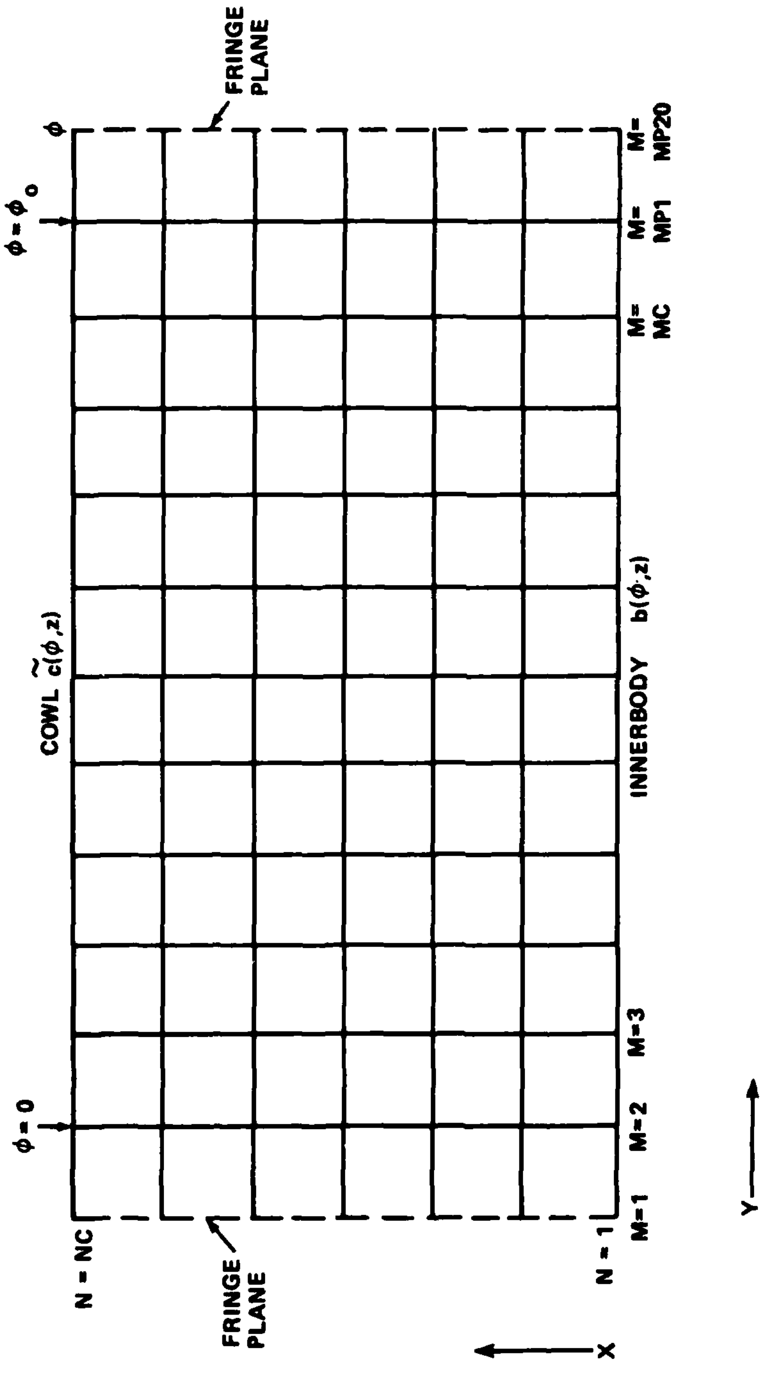


FIGURE 2. COMPUTATIONAL COORDINATES FOR AN INLET CONFIGURATION

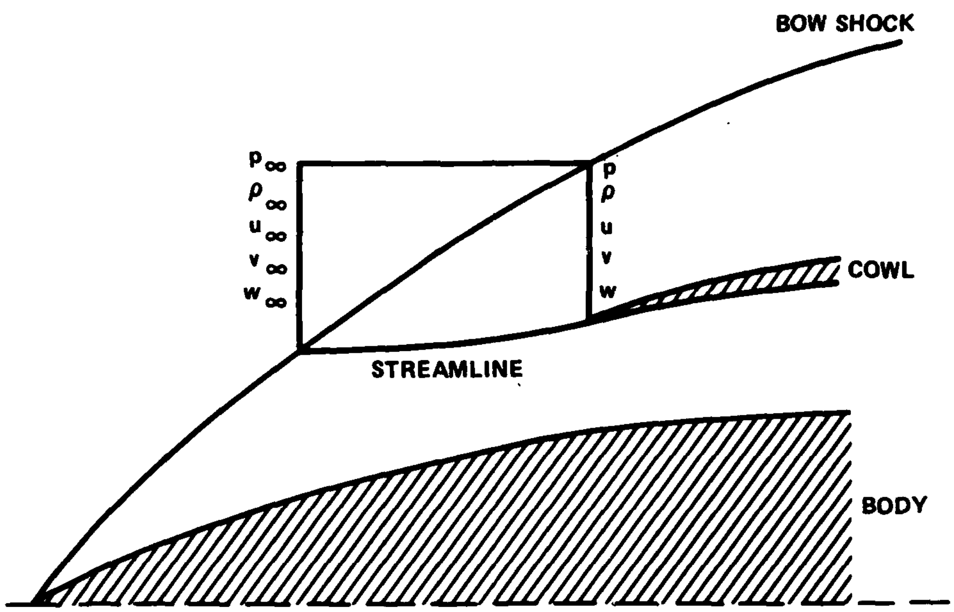


FIGURE 3. CONTROL VOLUME FOR CALCULATING INDUCED FORCES

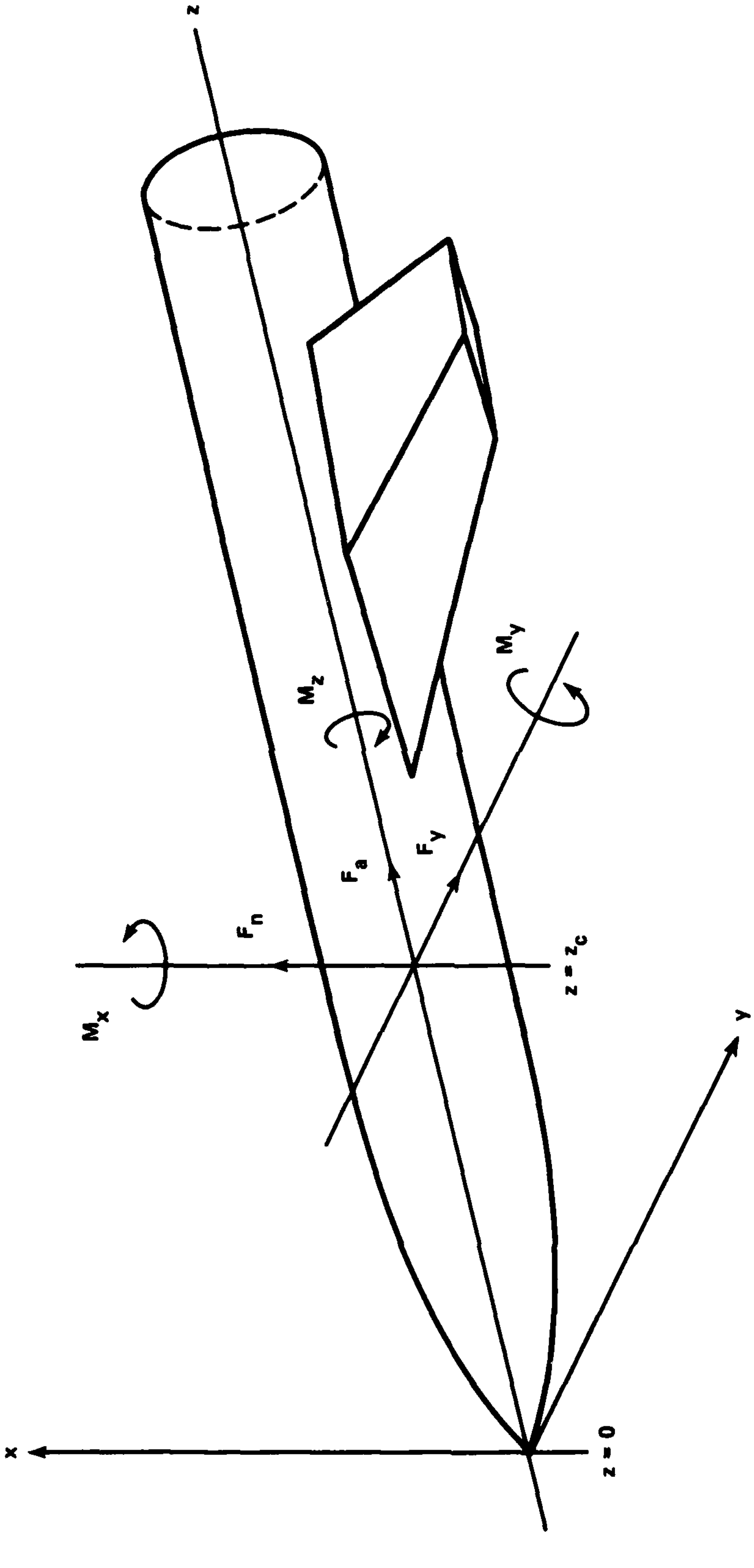
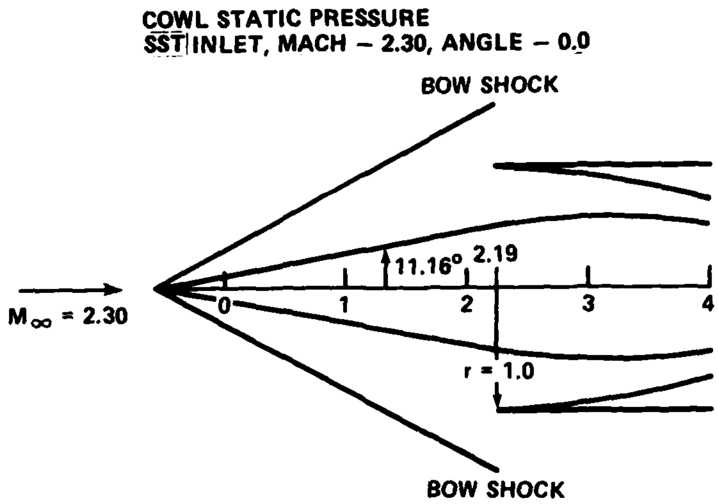


FIGURE 4. FORCE AND MOMENT SIGN CONVENTIONS



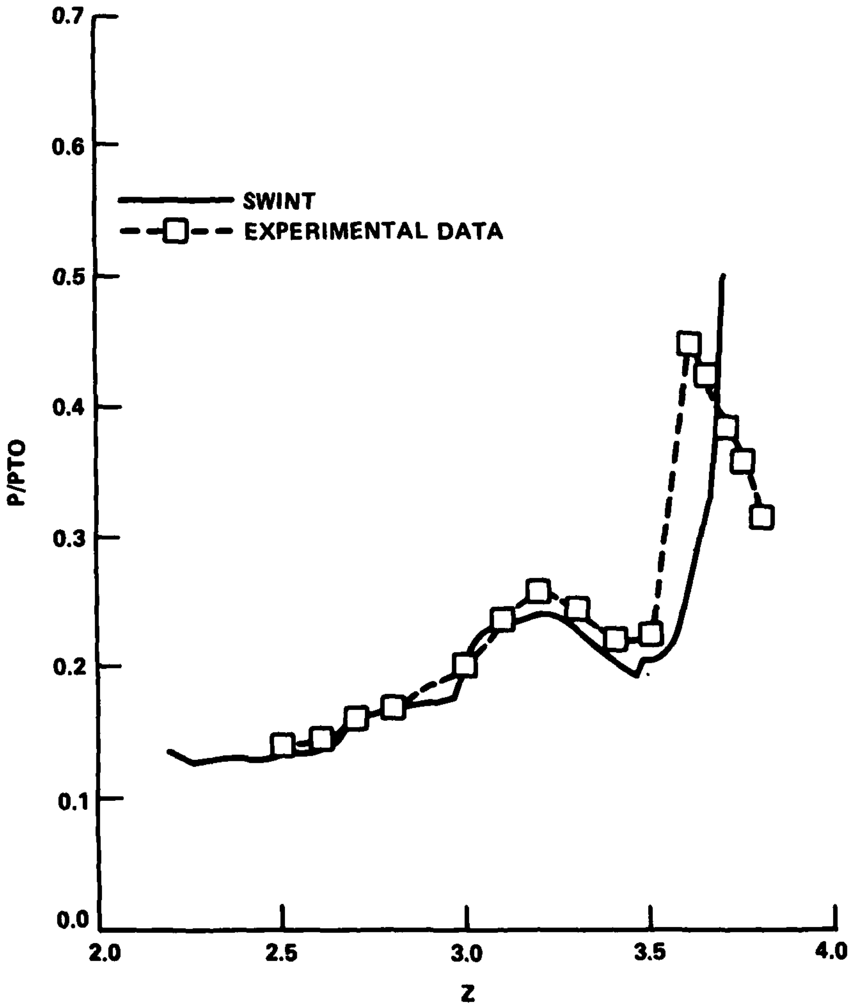
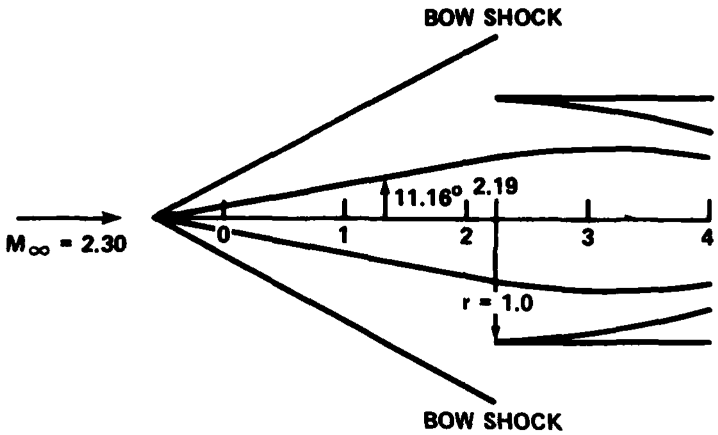


FIGURE 5. COMPARISON OF MEASURED AND CALCULATED SURFACE PRESSURES. EXPERIMENTAL DATA FROM REFERENCE 5

CENTERBODY STATIC PRESSURE
SST INLET, MACH – 2.30, ANGLE – 0.0



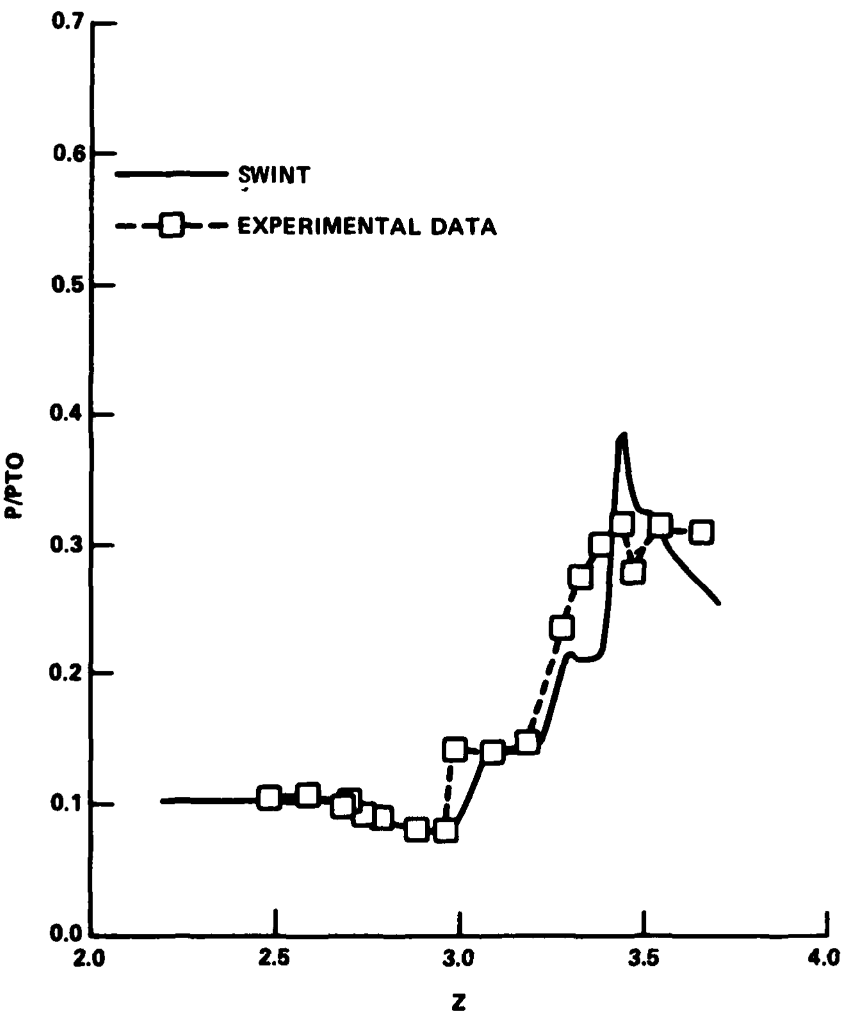


FIGURE 5. CONTINUED

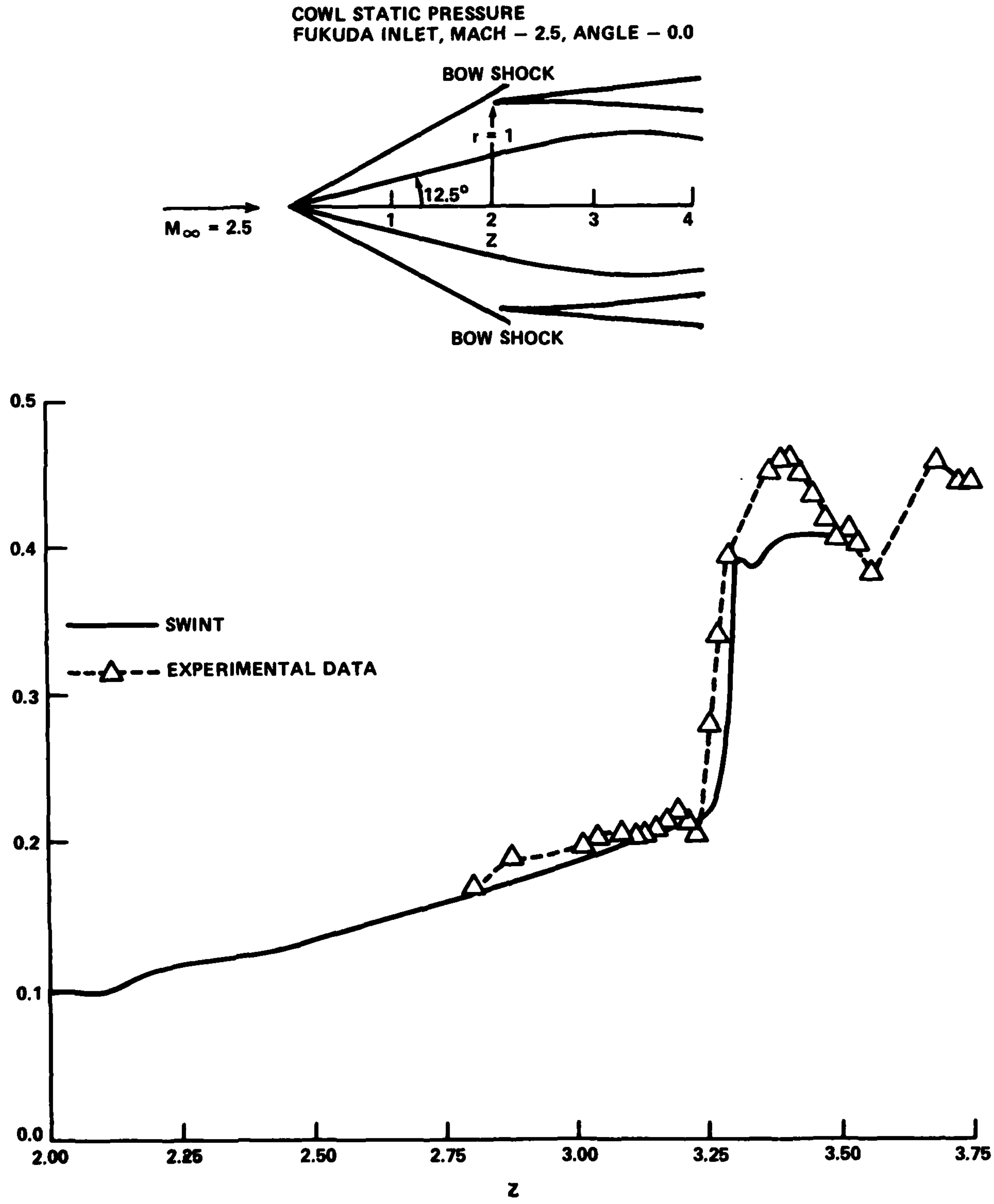
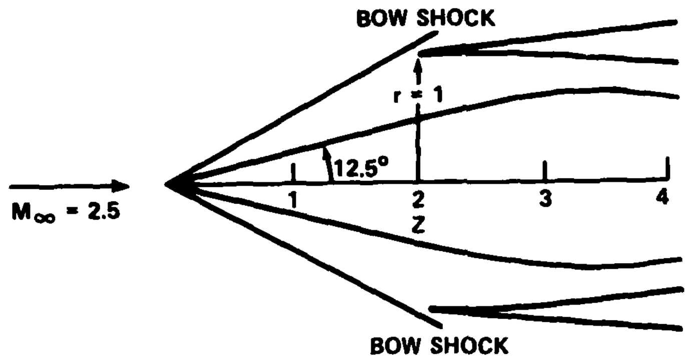


FIGURE 6. COMPARISON OF MEASURED AND CALCULATED SURFACE PRESSURES. EXPERIMENTAL DATA FROM REFERENCE 6

CENTERBODY STATIC PRESSURE
FUKUDA INLET, MACH – 2.5, ANGLE – 0.0



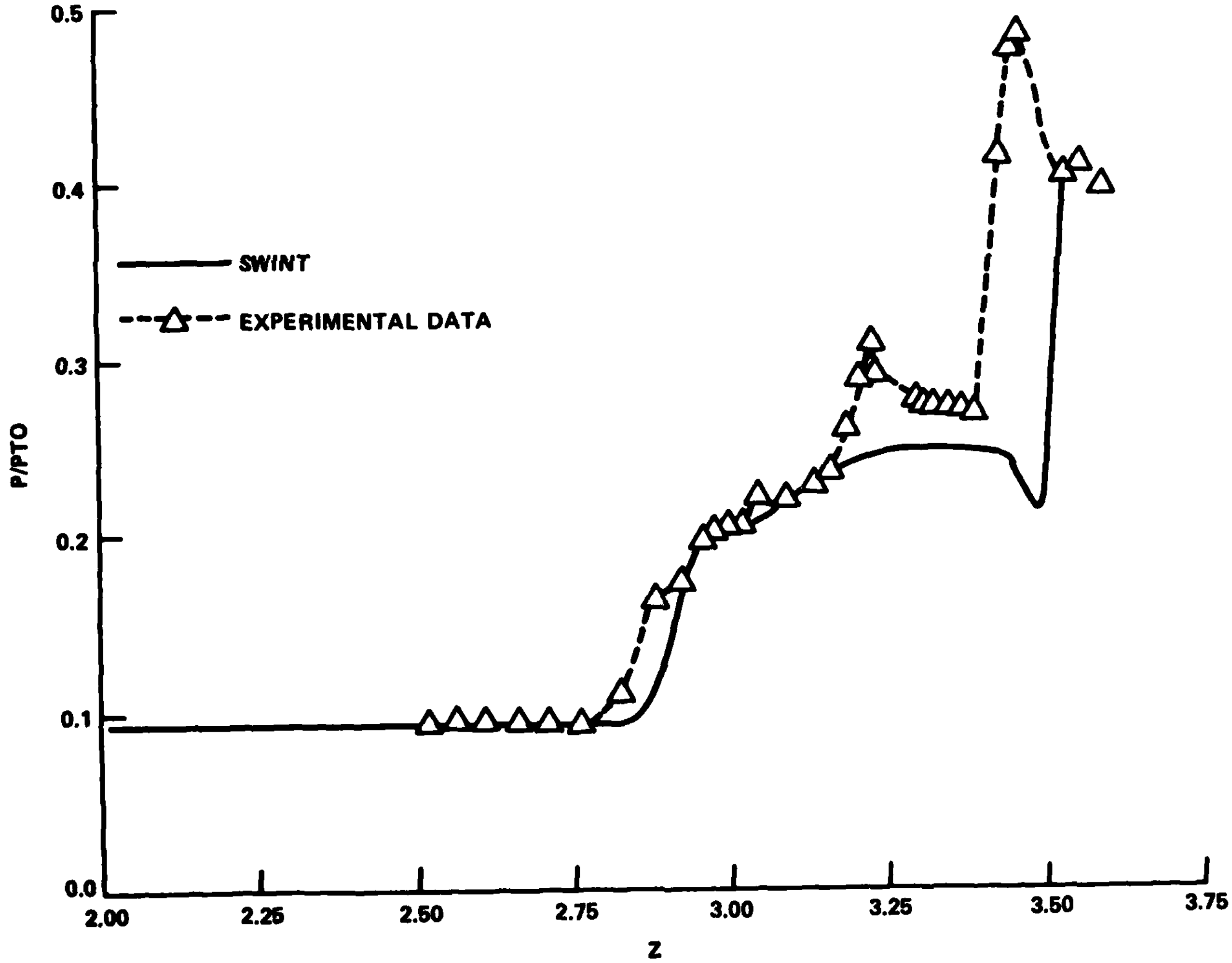
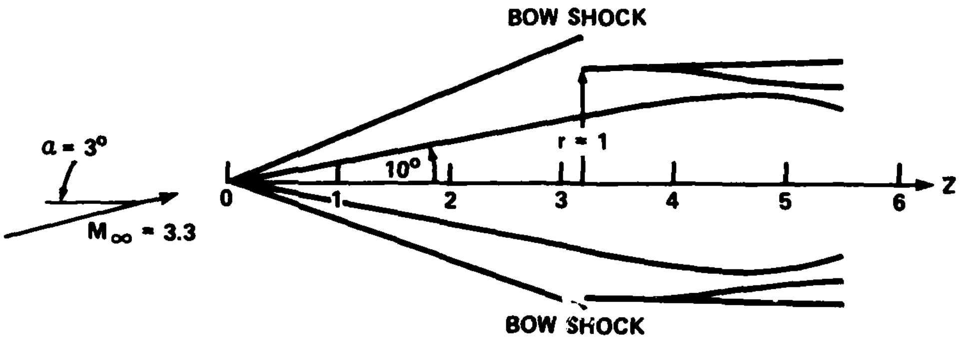


FIGURE 6. CONTINUED

COWL STATIC PRESSURE
PRESLEY INLET, MACH – 3.30, ANGLE – 3.0



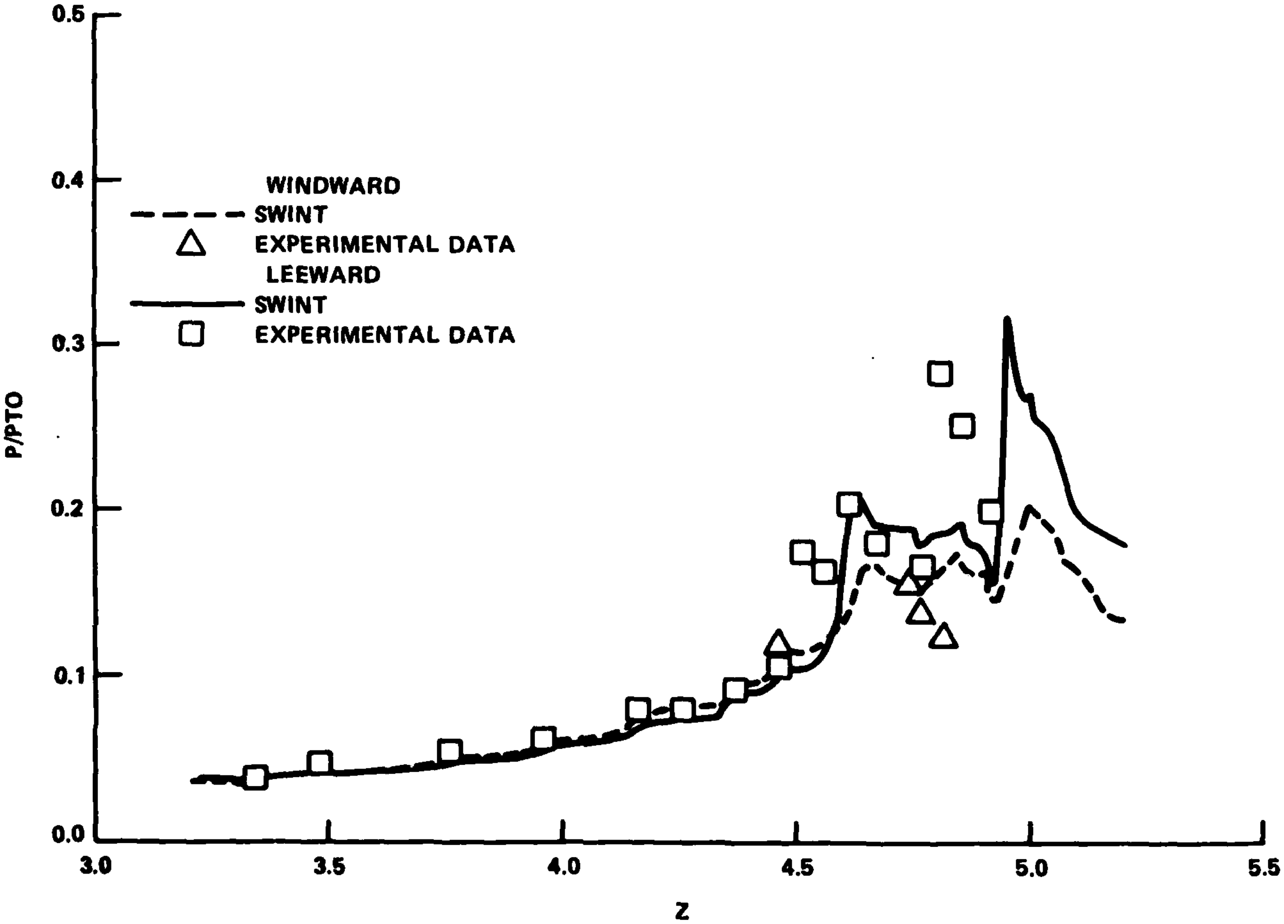
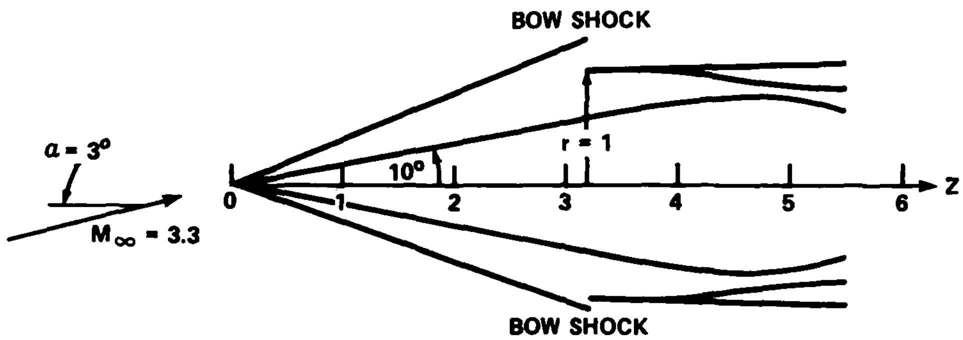


FIGURE 7. COMPARISON OF MEASURED AND CALCULATED SURFACE PRESSURES. EXPERIMENTAL DATA FROM REFERENCES 7 AND 8

CENTERBODY STATIC PRESSURE
PRESLEY INLET, MACH – 3.30, ANGLE – 3.0



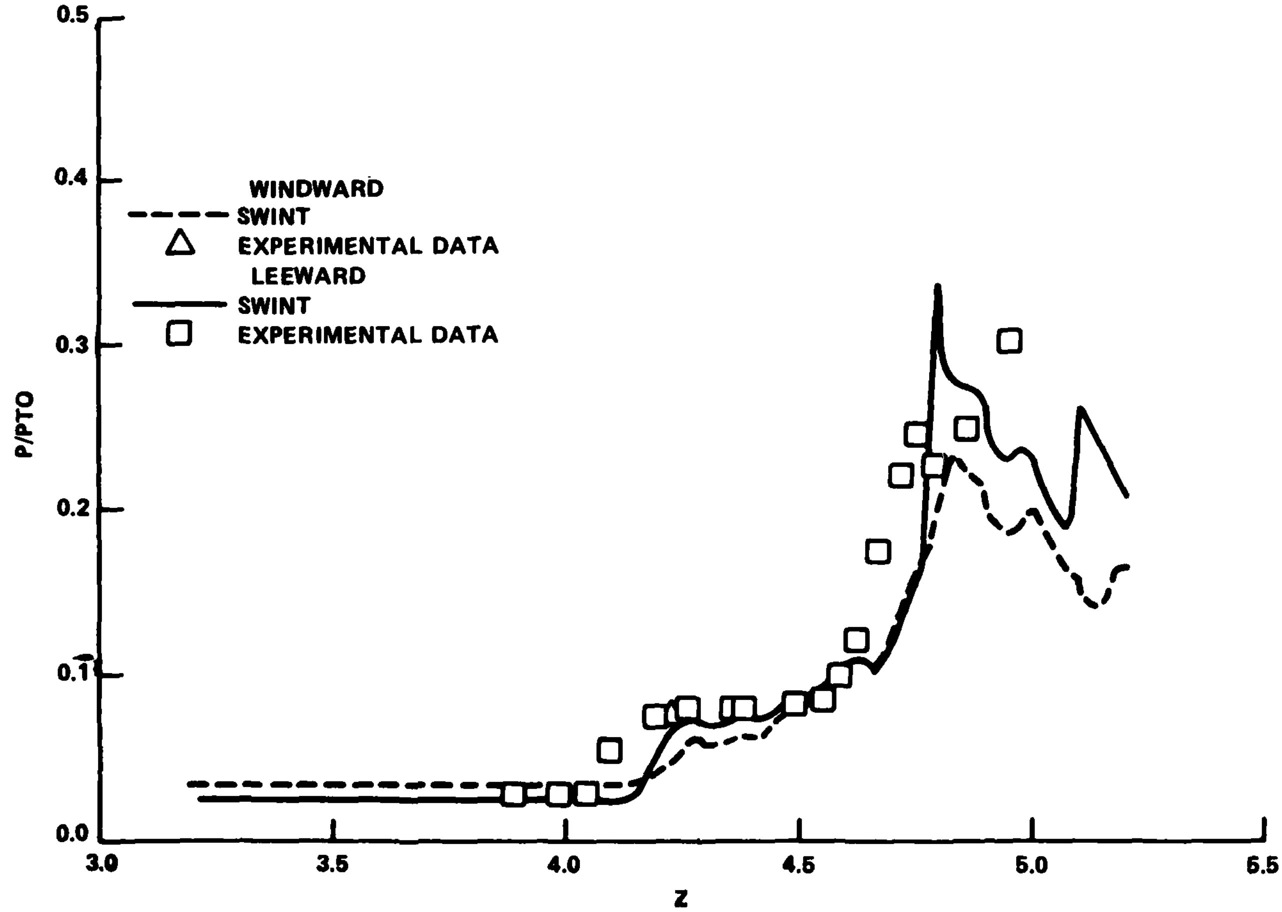


FIGURE 7. CONTINUED

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NOMENCLATURE

a	speed of sound
$b(\phi,z)$	Location of the body surface
$c(\phi,z)$	Location of bow shock
$\tilde{c}\ (\phi.z)$	Location of cowl surface
h	Enthalpy
H_o	Stagnation enthalpy
P	ln (p)
p	pressure
p_t	recovery pressure
$\bar{q}$	Velocity vector
(r,ϕ,z)	Cylindrical coordinates (see Figure 1)
s	Entropy
(u,v,w)	Velocity components in cylindrical coordinates (see Figure 1)

(X,Y,Z)	Computational coordinates
Δz	Computational marching step
ρ	Density
∞	Free stream conditions

APPENDIX A. COWLI PROGRAM LISTING

```
      PROGRAM COWLINT(INPUT=64,OUTPUT=64,TAPE5=INPUT,TAPE6=OUTPUT,       COWLINT    2
     1 TAPE3=512,TAPE11)                                                 COWLINT    3
C......THIS PROGRAM REZONES THE SHOCK LAYER AT THE INLET PLANE           COWLINT    4
C       TO INCLUDE ONLY THE FLOW ENTERING THE INLET.  IT CAN ALSO         COWLINT    5
C       BE USED TO GENERATE A STARTING FLOW FOR EXTERNAL CALCULATIONS     COWLINT    6
C       DOWN STREAM OF THE INLET PLANE WHEN THE BOW SHOCK OR PORTIONS     COWLINT    7
C       OF THE BOW SHOCK ARE INSIDE THE INLET.                            COWLINT    8
C            INPUT:                                                       COWLINT    9
C            TAPE11 - SWINT RESTART TAPE AT INLET FACE                    COWLINT   10
C            BNEW,BZNEW,BPHNEW - NEW BODY SHAPE AT INLET FACE.  NEED NOT  COWLINT   11
C                           ALWAYS BE SPECIFIED.(SEE IBODY DESCRIPTIO     COWLINT   12
C            CNEW,CZNEW,CPHNEW - SHAPE OF OUTER BOUNDARY. NEED NOT ALWAYS COWLINT   13
C                           BE SPECIFIED(SEE ICOWL DESCRIPTION)           COWLINT   14
C            IBODY - 0 : FLOW AT INNER BOUNDARY IS NOT ALTERED.           COWLINT   15
C                        BNEW,BZNEW,BPHNEW NEED NOT BE SPECIFIED.         COWLINT   16
C                    1 : FLOW AT INNER BOUNDARY IS TURNED TANGENT TO      COWLINT   17
C                        THE SURFACE. BNEW,BZNEW,BPHNEW MUST BE SPECIFIED. COWLINT  18
C                    2 : INNER BODY FLOW QUANITIES ARE PRESCRIBED ALONG   COWLINT   19
C                        EACH M PLANE. BNEW,BZNEW,BPHNEW MUST BE SPECIFIED COWLINT  20
C                        ICOWL MUST BE EQUAL 0 AND DDZ MUST BE PRESCRIBED. COWLINT  21
C            ICOWL - 0 : FLOW AT OUTER BOUNDARY IS NOT ALTERED.           COWLINT   22
C                        CNEW,CZNEW,CPHNEW MAY BE SPECIFIED. OTHERWISE    COWLINT   23
C                        OLD VALUES ARE USED.                             COWLINT   24
C                    1 : FLOW AT OUTER BOUNDARY TURNED TANGENT TO SURFACE COWLINT   25
C                        CNEW,CZNEW AND CPHNEW MUST BE SPECIFIED.         COWLINT   26
C                    2 : OUTER BOUNDARY IS A MACH CONE. CNEW,CPHNEW MUST  COWLINT   27
C                        BE SPECIFIED. CNEW MUST BE GREATER THEN C FOR ALL COWLINT  28
C                        PLANES.                                          COWLINT   29
C            AREA - REFERENCE AREA: DEFAULT IS BODY CROSSECTIONAL AREA    COWLINT   30
C                   AT THE INLET ENTRANCE PLANE.                          COWLINT   31
C            RCLUST - R DIRECTION CLUSTERING: DEFAULT IS UNIFORM MESH.    COWLINT   32
C            DDZ - DISTANCE FROM COWL LIP TO STARTING PLANE.  ONLY NEEDED COWLINT   33
C                  FOR IBODY=2.                                           COWLINT   34
C            IPRINT - 0 : DO NOT PRINT FLOW FIELD.                        COWLINT   35
C                     1 : PRINT FINAL FLOW FIELD. (DEFAULT)               COWLINT   36
C                     2 : PRINT ORIGINAL AND FINAL FLOW FIELD.            COWLINT   37
C                     3 : PRINT ORIGINAL,FINAL FLOW FIELD AND JUMP MESSAGE COWLINT  38
C          OUTPUT:                                                        COWLINT   39
C              TAPE3 - RESTART TAPE FOR SWINT                             COWLINT   40
      COMMON NC,MC,K,IPRINT,PINF,DINF,PHIO,PI,RAD,Z,BZZ,GAMMA,MOT2,BMAX,  COMST      2
     1S1,S2,C1,C2,CONVR,PTINF,                                            COMST      3
     1 C(100),CZ(100),CPHI(100),R(25,100),D(25,100),P(25,100),U(25,100),  COMST      4
     1 V(25,100),W(25,100),PHI(100)                                       COMST      5
     2 ,BNEW(100),CNEW(100),DUMV(26),DUMP(26),DUMU(26),DUMW(26),DUMD(26)  COMST      6
     3 ,BZNEW(100),BPHNEW(100),CZNEW(100),CPHNEW(100),ROLD(26)            COMST      7
     4  ,PTR(25,100),RCLUST(100),PHIL(102)                                COMST      8
      COMMON/RGASS/AX,HX,GX                                               RGASS      2
      REAL MX,MY,MZ,MXZ,MYZ,MZZ                                           COWLINT   43
      NAMELIST/INPUTS/BNEW,BZNEW,BPHNEW,CNEW,CZNEW,CPHNEW                 COWLINT   44
     1  ,IBODY,ICOWL,AREF,RCLUST,DDZ,IPRINT                               COWLINT   45
C.....INITIALIZE DATA                                                     COWLINT   46
      DO 5 M=1,25                                                         COWLINT   47
         BNEW(M)=-1.                                                      COWLINT   48
         CNEW(M)=-1.                                                      COWLINT   49
    5 CONTINUE                                                            COWLINT   50
      DDZ=0.                                                              COWLINT   51
      IPRINT = 1                                                          COWLINT   52
      PTRTOT = 0.0                                                        COWLINT   53
      PTRINL = 0.0                                                        COWLINT   54
      AINL = 0.0                                                          COWLINT   55
      AREAT = 0.0                                                         COWLINT   56
      FADDA = 0.0                                                         COWLINT   57
      FADDN = 0.0                                                         COWLINT   58
      FADDY = 0.0                                                         COWLINT   59
      FADDAT=0.                                                           COWLINT   60
      FADDNT=0.                                                           COWLINT   61
      FADDYT=0.                                                           COWLINT   62
      SUMINM=0.                                                           COWLINT   63
      ICOWL = 1                                                           COWLINT   64
      IBODY=0                                                             COWLINT   65
      AREF = 0.0                                                          COWLINT   66
C                                                                         COWLINT   67
C.....READ FLOW FIELD                                                     COWLINT   68
C                                                                         COWLINT   69
      READ(11)NC,MC,ATTACK,YAW,ACH,GAMMA,PINF,DINF,PHIO,K,Z,              COWLINT   70
     2  FN,FY,FA,MX,MY,MZ,FNZ,FYZ,FAZ,MXZ,MYZ,MZZ,                        COWLINT   71
     3 (PHI(M),C(M),CZ(M),CPHI(M),M=1,MC)                                 COWLINT   72
     4 ,  ((R(N,M),U(N,M),V(N,M),W(N,M),P(N,M),D(N,M),                    COWLINT   73
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     5  M = 1,MC),N=1,NC)                                                  COWLINT   74
      IF(EOF(11))1000,25                                                   COWLINT   75
C                                                                          COWLINT   76
   25 CONTINUE                                                             COWLINT   77
      DO 3 N=1,NC                                                          COWLINT   78
        RCLUST(N)=(N-1.)/(NC-1.)                                           COWLINT   79
    3 CONTINUE                                                             COWLINT   80
C                                                                          COWLINT   81
C.....READ GEOMETRY DATA                                                   COWLINT   82
      READ(5,INPUTS)                                                       COWLINT   83
      WRITE(6,INPUTS)                                                      COWLINT   84
      PI = 4.0 * ATAN(1.0)                                                 COWLINT   85
      CONVR=180./PI                                                        COWLINT   86
      ATWO=0.                                                              COWLINT   87
      MP2=MC+2                                                             COWLINT   88
      MP1=MC+1                                                             COWLINT   89
      DO 10 M=2,MP1                                                        COWLINT   90
      PHIL(M)=PHI(M-1)                                                     COWLINT   91
   10 CONTINUE                                                             COWLINT   92
      PHIL(1)=PHI(1)                                                       COWLINT   93
      PHIL(MP2)=PHI(MC)                                                    COWLINT   94
      IF(ABS(PHIO-2*PI).GT.1.E-06)GO TO 11                                 COWLINT   95
      PHIL(1)=-PHI(2)                                                      COWLINT   96
      PHIL(MP2)=2.*PI                                                      COWLINT   97
   11 CONTINUE                                                             COWLINT   98
C.....COMPUTE REFERENCE AREA                                               COWLINT   99
      DO 4 M = 1, MC                                                       COWLINT  100
         IM1 = 0                                                           COWLINT  101
         IMC = 2                                                           COWLINT  102
         ATWO = ATWO + 0.25 * (PHIL(M+IMC)-PHIL(M-IM1)) * R(1,M)*R(1,M)    COWLINT  103
    4 CONTINUE                                                             COWLINT  104
         ATWO = ATWO * 2.0 * PI / PHIO                                     COWLINT  105
    2 CONTINUE                                                             COWLINT  106
      IF(AREF.EQ.0.0)AREF=ATWO                                             COWLINT  107
C.....CALCULATE CONSTANTS                                                  COWLINT  108
      GX=GAMMA                                                             COWLINT  109
      NCM1=NC-1                                                            COWLINT  110
      RAD=PI/180.                                                          COWLINT  111
      ALPHA=ATTACK*RAD                                                     COWLINT  112
      S4=SIN(ALPHA)                                                        COWLINT  113
      VINF=SQRT(GAMMA*PINF/DINF)*ACH                                       COWLINT  114
      YAWR = YAW * RAD                                                     COWLINT  115
      WINF = VINF * COS(YAWR) * COS(ALPHA)                                 COWLINT  116
      V1INF = VINF * COS(YAWR) * S4                                        COWLINT  117
      V2INF = -VINF * SIN(YAWR)                                            COWLINT  118
      PTINF = PINF*(1.0 +(GAMMA-1.0) / 2.0 * ACH**2.0) ** (GAMMA/          COWLINT  119
     1  (GAMMA-1.0))                                                       COWLINT  120
      HO=GAMMA*PINF/((GAMMA-1.)*DINF)+VINF**2/2.                           COWLINT  121
      CALL RGAS(PINF,DINF,SINF)                                            COWLINT  122
C.....PRINT FREE STREAM CONDITIONS                                         COWLINT  123
      WRITE(6,5000)ACH,ATTACK,YAW,VINF,PINF,DINF,HO,SINF,PTINF             COWLINT  124
 5000 FORMAT(1H1,5X,38H******* FREE STREAM CONDITIONS *******,/            COWLINT  125
     1,15X,15HMACH NUMBER    ,F15.7,/                                      COWLINT  126
     2,15X,15HANGLE OF ATTACK,F15.7,/                                      COWLINT  127
     3,15X,15HYAW ANGLE      ,F15.7,/                                      COWLINT  128
     4,15X,15HVINF           ,F15.7,/                                      COWLINT  129
     5,15X,15HPINF           ,F15.7,/                                      COWLINT  130
     6,15X,15HDINF           ,F15.7,/                                      COWLINT  131
     7,15X,15HHO             ,F15.7,/                                      COWLINT  132
     8,15X,15HSINF           ,F15.7,/                                      COWLINT  133
     9,15X,15HPTINF          ,F15.7,///)                                   COWLINT  134
C.....PROBLEM SET UP                                                       COWLINT  135
      WRITE(6,5001)NC,MC,IBODY,DDZ,ICOWL                                   COWLINT  136
      WRITE(6,5003)(N,RCLUST(N),N=1,NC)                                    COWLINT  137
 5003 FORMAT(6X,27H******* CLUSTERING ********,/                           COWLINT  138
     1 6X,1HN,7X,10HCLUSTERING,/                                           COWLINT  139
     2   (2X,I5,F15.7))                                                    COWLINT  140
      WRITE(6,5005)                                                        COWLINT  141
 5005 FORMAT(///)                                                          COWLINT  142
 5001 FORMAT(1H0,5X,30H******* PROBLEM SET UP *******,/                    COWLINT  143
     1 ,15X,15HNC              ,I5,/                                       COWLINT  144
     2 ,15X,15HMC              ,I5,/                                       COWLINT  145
     3 ,15X,15HIBODY           ,I5,/                                       COWLINT  146
     3 ,15X,15HDDZ             ,F10.5,/                                    COWLIN'  147
     4 ,15X,15HICOWL           ,I5,///)                                    COWLINT  148
      HOT2=2.*HO                                                           COWLINT  149
      E1 = PINF / DINF / WINF                                              COWLINT  150
      E3 = 0.5 * DINF * VINF*VINF * AREF                                   COWLINT  151
C.....MAKE NEW GEOMETRY AXISYMETRIC IF ONLY ONE VALUE IS GIVEN             COWLINT  152
      DO 6 M=2,MC                                                          COWLINT  153
         IF (CNEW(M).GT.0.)GO TO 7                                         COWLINT  154
         CNEW(M)=CNEW(M-1)                                                 COWLINT  155
         CZNEW(M)=CZNEW(M-1)                                               COWLINT  156
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      CPHNEW(M)=CPHNEW(M-1)                                             COWLINT  157
    7 CONTINUE                                                          COWLINT  158
      IF(BNEW(M).GT.0.)GO TO 6                                          COWLINT  159
      BNEW(M)=BNEW(M-1)                                                 COWLINT  160
      BZNEW(M)=BZNEW(M-1)                                               COWLINT  161
      BPHNEW(M)=BPHNEW(M-1)                                             COWLINT  162
    6 CONTINUE                                                          COWLINT  163
C.........USE TAPE READ GEOMETRY IF NO VALUE IS GIVEN                   COWLINT  164
      DO 8 M=1,MC                                                       COWLINT  165
      IF(BNEW(M).LT.0.)BNEW(M)=R(1,M)                                   COWLINT  166
      IF(CNEW(M).GT.0.)GO TO 8                                          COWLINT  167
      CNEW(M)=C(M)                                                      COWLINT  168
      CZNEW(M)=CZ(M)                                                    COWLINT  169
      CPHNEW(M)=CPHI(M)                                                 COWLINT  170
    8 CONTINUE                                                          COWLINT  171
      WRITE(6,5002)(M,BNEW(M),BZNEW(M),BPHNEW(M),CNEW(M),               COWLINT  172
     1 CZNEW(M),CPHNEW(M),M=1,MC)                                       COWLINT  173
 5002 FORMAT('0',5X,29H******* COWL GEOMETRY *******,/                  COWLINT  174
     1   5X,1HM,12X,1HB,13X,2HBZ,11X,4HBPHI,14X,1HC,13X,2HCZ,11X,4HCPHI/ COWLINT  175
     2  (' ',I5,6F15.7))                                                COWLINT  176
C.....PRINT ORIGINAL FLOW FIELD                                         COWLINT  177
      IF(IPRINT.GT.1)WRITE(6,5006)                                      COWLINT  178
 5006 FORMAT(1H1,10X,19HORIGINAL FLOW FIELD)                            COWLINT  179
      IF(IPRINT.GT.1)CALL OUTPUT(ACH,ATTACK,YAW)                        COWLINT  180
C                                                                       COWLINT  181
                                                                        COWLINT  182
C                                                                       COWLINT  183
C.....PRE-COWL FLOW FIELD, SHOCK IS OUTER BOUNDRY                       COWLINT  184
C                                                                       COWLINT  185
      DO 31 M = 1, MC                                                   COWLINT  186
      IMO = 1                                                           COWLINT  187
      IMC = 2                                                           COWLINT  188
      IFLAG = 0                                                         COWLINT  189
C.........LOCAL VALUES ARE CALCULATED                                   COWLINT  190
C.........SOME ARE AREA WEIGHTED AND SUMMED                             COWLINT  191
      DO 30 N = 1, NC                                                   COWLINT  192
      AX = SQRT(GX*P(N,M)/D(N,M))                                       COWLINT  193
      AMACH = SQRT(U(N,M)**2.0 + V(N,M)**2.0 + W(N,M)**2.0)/AX          COWLINT  194
      PTR(N,M) = P(N,M)  * (1.0 + (GAMMA-1.0)/2.0 *                     COWLINT  195
     1   AMACH**2.0) ** (GAMMA/(GAMMA-1.0))                             COWLINT  196
      IN1 = 1                                                           COWLINT  197
      INC = 1                                                           COWLINT  198
      IF (N .EQ. 1) IN1 = 0                                             COWLINT  199
      IF (N .EQ. NC) INC = 0                                            COWLINT  200
C............WEIGHTING AREA FOR LOCAL POINT WITH ADJUSTMENTS            COWLINT  201
C.............FOR FIELD EDGES                                           COWLINT  202
      AREA = 0.25 * (PHIL(M+IMC)-PHIL(M-IM1)) * ((0.5*(R(N,M)+          COWLINT  203
     1  R(N+INC,M)))**2.0 - (0.5*(R(N-IN1,M)+R(N,M)))**2.0)             COWLINT  204
      AREAT = AREAT + AREA                                              COWLINT  205
      E2 = D(N,M) * W(N,M) * AREA                                       COWLINT  206
      V1 = -U(N,M) * COS(PHI(M)) + V(N,M) * SIN(PHI(M))                 COWLINT  207
      V2 = U(N,M) * SIN(PHI(M)) + V(N,M) * COS(PHI(M))                  COWLINT  208
      FADDAT = FADDAT + ((WINF-W(N,M)) + E1 - P(N,M)/D(N,M)             COWLINT  209
     1  /W(N,M)) * E2                                                   COWLINT  210
      FADDNT = FADDNT + (V1INF-V1) * E2                                 COWLINT  211
      FADDYT = FADDYT + (V2INF-V2) * E2                                 COWLINT  212
      PTRTOT = PTRTOT + PTR(N,M) * AREA                                 COWLINT  213
      IF(R(N,M).LE.CNEW(M))GO TO 29                                     COWLINT  214
C.....ELEMENT INTERSECTED BY COWL                                       COWLINT  215
      IF (N .EQ. 1) GO TO 29                                            COWLINT  216
C............CONDITION WHEN INSIDE SPILLAGE REGION                      COWLINT  217
C.............BUT NOT IN COWL VICINITY                                  COWLINT  218
      IF (IFLAG .EQ. 1) GO TO 28                                        COWLINT  219
C............SPILLAGE MOMENTUM ADDITION (+ OR - DEPENDING ON WHICH      COWLINT  220
C.............LOCAL POINT AREA THE COWL IS IN)                          COWLINT  221
      AREAB = 0.25 * (PHIL(M+IMC)-PHIL(M-IM1)) * ((0.5*(R(N,M)+         COWLINT  222
     1  R(N-1,M)))**2.0 - CNEW(M)**2.0)                                 COWLINT  223
      NB = N                                                            COWLINT  224
      IF (0.5*(R(N,M)+R(N-1,M)) .GT. CNEW(M)) NB = N - 1                COWLINT  225
      E2 = D(NB,M) * W(NB,M) * AREAB                                    COWLINT  226
      V1 = -U(NB,M) * COS(PHI(M)) + V(NB,M) * SIN(PHI(M))               COWLINT  227
      V2 = U(NB,M) * SIN(PHI(M)) + V(NB,M) * COS(PHI(M))                COWLINT  228
      FADDA = FADDA + ((WINF-W(NB,M)) + E1 - P(NB,M)/D(NB,M)            COWLINT  229
     1  /W(NB,M)) * E2                                                  COWLINT  230
      FADDN = FADDN + (V1INF-V1) * E2                                   COWLINT  231
      FADDY = FADDY + (V2INF-V2) * E2                                   COWLINT  232
      SUMINM = SUMINM - D(NB,M) * W(NB,M) * AREAB                       COWLINT  233
      PTRINL = PTRINL - PTR(NB,M) * AREAB                               COWLINT  234
      AINL = AINL - AREAB                                               COWLINT  235
      IFLAG = 1                                                         COWLINT  236
C............WHOLE LOCAL AREA MOMENTUM IS SUMMED                        COWLINT  237
C........OUTSIDE COWL                                                   COWLINT  238
   28 CONTINUE                                                          COWLINT  239
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              E2 = D(N,M) * W(N,M) * AREA                                COWLINT  240
              V1 = -U(N,M) * COS(PHI(M)) + V(N,M) * SIN(PHI(M))          COWLINT  241
              V2 = U(N,M) * SIN(PHI(M)) + V(N,M) * COS(PHI(M))           COWLINT  242
              FADDA = FADDA + ((WINF-W(N,M)) + E1 - P(N,M)/D(N,M)        COWLINT  243
     1          /W(N,M)) * E2                                            COWLINT  244
              FADDN = FADDN + (V1INF-V1) * E2                            COWLINT  245
              FADDY = FADDY + (V2INF-V2) * E2                            COWLINT  246
              GO TO 30                                                   COWLINT  247
C.....INSIDE COWL                                                         COWLINT  248
   29         SUMINM = SUMINM + D(N,M) * W(N,M) * AREA                   COWLINT  249
              PTRINL = PTRINL + PTR(N,M) * AREA                          COWLINT  250
              AINL = AINL + AREA                                         COWLINT  251
   30     CONTINUE                                                       COWLINT  252
          IF(R(NC,M).GT.CNEW(M))GO TO 31                                 COWLINT  253
C.....SHOCK INSIDE COWL                                                   COWLINT  254
          AREA=.25*(PHIL(M+IMC)-PHIL(M-IM1))*(CNEW(M)**2-R(NC,M)**2)     COWLINT  255
          SUMINM=SUMINM+DINF*WINF*AREA                                   COWLINT  256
          PTRINL=PTRINL+PTINF*AREA                                       COWLINT  257
          AINL=AINL+AREA                                                 COWLINT  258
   31 CONTINUE                                                           COWLINT  259
C.....TOTAL FORCES                                                        COWLINT  260
      FADDAT=FADDAT*2.*PI/PHIO                                           COWLINT  261
      FADDNT=FADDNT*2.*PI/PHIO                                           COWLINT  262
      IF(ABS(PHIO-2.*PI).GT.1.E-06)FADDYT=0.                             COWLINT  263
      IF(ABS((PHIO-PI)*(PHIO-2.*PI)).GT.1.E-06)FADDNT=0.                 COWLINT  264
      FAA=FA+ATWO*PINF                                                   COWLINT  265
      ERRA=(FADDAT-FAA)/FAA*100.                                         COWLINT  266
      ERRN=(FADDNT-FN)/SIGN(AMAX1(ABS(FN),1.E-08),FN)*100.               COWLINT  267
      ERRY=(FADDYT-FY)/SIGN(AMAX1(ABS(FY),1.E-08),FY)*100.               COWLINT  268
C.....INDUCED DRAG                                                        COWLINT  269
      FADDA=FADDA*2.*PI/(PHIO*E3)                                        COWLINT  270
      FADDN=FADDN*2.*PI/(PHIO*E3)                                        COWLINT  271
      FADDY=FADDY/E3                                                     COWLINT  272
      IF(ABS(PHIO-2.*PI).GT.1.E-06)FADDY=0.                              COWLINT  273
      IF(ABS((PHIO-PI)*(PHIO-2.*PI)).GT.1.E-06)FADDN=0.                  COWLINT  274
C.....TOTAL PRESSURE RECOVERY DATA PRINTED                                COWLINT  275
      PR = PTRTOT / AREAT                                                COWLINT  276
      PRINL = PTRINL / AINL                                              COWLINT  277
      AREAT=AREAT*2.*PI/PHIO                                             COWLINT  278
      AINL=AINL*2.*PI/PHIO                                               COWLINT  279
      SUMINM=SUMINM*2.*PI/PHIO                                           COWLINT  280
      WRITE (6,2000)                                                     COWLINT  281
 2000 FORMAT(34H1INLET PLANE FLOW FIELD PARAMETERS)                      COWLINT  282
      PRINLR=PRINL/PTINF                                                 COWLINT  283
      PRR=PR/PTINF                                                       COWLINT  284
      WRITE(6,2010)PRR,PRINLR,AREAT,AINL,SUMINM,FADDA,ERRA,              COWLINT  285
     1 FADDN,ERRN,FADDY,ERRY,AREF                                        COWLINT  286
 2010 FORMAT(1H0,10X,44HSHOCK LAYER AVERAGE PRESSURE RECOVERY RATIO ,    COWLINT  287
     1 F15.7,/,                                                          COWLINT  288
     1   10X,45H INLET AVERAGE PRESSURE RECOVERY RATIO       ,F15.7,/,   COWLINT  289
     2   10X,45H SHOCK LAYER CROSSECTIONAL AREA              ,F15.7,/,   COWLINT  290
     3   10X,45H INLET ENTRANCE CROSSECTIONAL AREA           ,F15.7,/,   COWLINT  291
     4   10X,45H MASS CAPTURED BY THE INLET                  ,F15.7,/,   COWLINT  292
     4   10X,45H ADDATIVE AXIAL FORCE COEFFICIENT            ,F15.7,     COWLINT  293
     4   4X,29H  TOTAL DRAG ERROR          ,F10.4,4H O/O,/,              COWLINT  294
     5   10X,45H ADDATIVE NORMAL FORCE COEFFICIENT           ,F15.7,     COWLINT  295
     5   4X,29H  TOTAL NORMAL FORCE ERROR  ,F10.4,4H O/O,/,              COWLINT  296
     6   10X,45H ADDATIVE YAW FORCE COEFFICIENT              ,F15.7,     COWLINT  297
     6   4X,29H  TOTAL YAW FORCE ERROR     ,F10.4,4H O/O,/,              COWLINT  298
     7   10X,45H REFERENCE AREA                              ,F15.7/1H1) COWLINT  299
      DO 45 M=1,MC                                                       COWLINT  300
C........FREE STREAM FLOW FIELD VALUES ASSIGNED BEYOND SHOCK              COWLINT  301
          ROLD(NC+1)=2.*R(NC,M)-R(NCM1,M)                                COWLINT  302
          S1=SIN(PHI(M))                                                 COWLINT  303
          C1=COS(PHI(M))                                                 COWLINT  304
          DUMP(NC+1)=PINF                                                COWLINT  305
          DUMD(NC+1)=DINF                                                COWLINT  306
          DUMU(NC+1)=-VINF*S4*C1                                         COWLINT  307
          DUMV(NC+1)=VINF*S4*S1                                          COWLINT  308
          DUMW(NC+1)=SQRT(VINF*VINF-DUMU(NC+1)**2-DUMV(NC+1)**2)         COWLINT  309
          DO 50 N=1,NC                                                   COWLINT  310
C...........PRE-COWL FLOW FIELD STORED                                    COWLINT  311
              ROLD(N)=R(N,M)                                             COWLINT  312
              DUMP(N)=P(N,M)                                             COWLINT  313
              DUMD(N)=D(N,M)                                             COWLINT  314
              DUMU(N)=U(N,M)                                             COWLINT  315
              DUMV(N)=V(N,M)                                             COWLINT  316
              DUMW(N)=W(N,M)                                             COWLINT  317
C...........NEW COMPUTATIONAL GRID INSIDE COWL                            COWLINT  318
              R(N,M) = BNEW(M) + (CNEW(M)-BNEW(M)) * RCLUST(N)           COWLINT  319
   50     CONTINUE                                                       COWLINT  320
```

```
               DO 60 N=1,NC
                  DO 65 J=1,NC
C..............DETERMINE IF R(N,M) IS INSIDE OLD SHOCK
                     IF((R(N,M)-ROLD(J))*(R(N,M)-ROLD(J+1)).GT.0.)GO TO 65
                     JJ=J
                     GO TO 70
   65             CONTINUE
C............OUTSIDE OLD SHOCK, FREE STREAM (F) VALUES GIVEN TO R(N,M)
                  P(N,M)=PINF
                  D(N,M)=DINF
                  U(N,M)=-VINF*S4*C1
                  V(N,M)=VINF*S4*S1
                  W(N,M)=SQRT(VINF*VINF-U(N,M)**2-V(N,M)**2)
                  GO TO 60
   70             CONTINUE
C............INSIDE OLD SHOCK, INTERPOLATED (I) VALUES GIVEN TO R(N,M)
                  JJ1=JJ+1
                  FAC=(R(N,M)-ROLD(JJ))/(ROLD(JJ1)-ROLD(JJ))
                  U(N,M)=DUMU(JJ)+(DUMU(JJ1)-DUMU(JJ))*FAC
                  V(N,M)=DUMV(JJ)+(DUMV(JJ1)-DUMV(JJ))*FAC
                  P(N,M)=DUMP(JJ)+(DUMP(JJ1)-DUMP(JJ))*FAC
                  D(N,M)=DUMD(JJ)+(DUMD(JJ1)-DUMD(JJ))*FAC
                  W(N,M)=SQRT(HOT2-P(N,M)*GAMMA*2./((GAMMA-1.)*D(N,M))
     1               -U(N,M)**2-V(N,M)**2)
   60          CONTINUE
            IF(IBODY.EQ.0)GO TO 41
C.........BODY JUMP (VALID ONLY FOR AN UNSWEPT LEADING EDGE)
               BZO=(U(1,M)-V(1,M)*BPHNEW(M)/BNEW(M))/W(1,M)
               DELBZ=BZO-BZNEW(M)
               SIDE=ASIN(1./ACH)
               IF(ABS(DELBZ).LE.1.E-06)GO TO 43
               DELBP=0.
               SIDE = 1.
               CALL JUMPST(DELBP,DELBZ,M,1,BNEW(M),BZNEW(M),BPHNEW(M),SIDE)
               U(1,M) = SIGN (U(1,M), BZNEW(M))
                  IF(IBODY.EQ.1)GO TO 41
C..............UNIFORM FLOW FROM BODY TO SHOCK
   43 CONTINUE
            CZNEW(M)=TAN(SIDE+ATAN(BZNEW(M)))
            CNEW(M)=BNEW(M)+DDZ*(CZNEW(M)-BZNEW(M))
            CPHNEW(M)=BPHNEW(M)
            Z=Z+DDZ
            ICOWL=0
                  DO 42 N=2,NC
                  R(N,M)=BNEW(M)+(CNEW(M)-BNEW(M))*RCLUST(N)
                  U(N,M)=U(1,M)
                  V(N,M)=V(1,M)
                  W(N,M)=W(1,M)
                  P(N,M)=P(1,M)
                  D(N,M)=D(1,M)
   42             CONTINUE
   41          CONTINUE
               IF (ICOWL .EQ. 1) GO TO 44
C.........COMPUTE CZ FOR MACH ZONE
               IF(ICOWL.EQ.2)
     1         CZNEW(M)=(U(NC,M)-CPHNEW(M)*V(NC,M)/CNEW(M)
     2                  +SQRT(GAMMA*P(NC,M)/D(NC,M)))/W(NC,M)
               GO TO 45
   44          CONTINUE
C.........COWL JUMP(VALID ONLY FOR UNSWEPT LEADING EDGE)
               BZO=(U(NC,M)-V(NC,M)*CPHNEW(M)/CNEW(M))/W(NC,M)
               DELBZ=BZO-CZNEW(M)
               IF(ABS(DELBZ).LE.1.E-6)GO TO 45
               DELBP=0.
               SIDE=-1.
               CALL JUMPST(DELBP,DELBZ,M,NC,CNEW(M),CZNEW(M),CPHNEW(M),SIDE)
               U(NC,M) = SIGN (U(NC,M), CZNEW(M))
   45 CONTINUE
            WRITE(3)NC,MC,ATTACK,YAW,ACH,GAMMA,PINF,DINF,PHIO,K,Z
     1      ,FN,FY,FA,MX,MY,MZ,FNZ,FYZ,FAZ,MXZ,MYZ,MZZ
     2      ,(PHI(M),CNEW(M),CZNEW(M),CPHNEW(M),M=1,MC)
     3      ,((R(N,M),U(N,M),V(N,M),W(N,M),P(N,M),D(N,M),M=1,MC),N=1,NC)
C.....PRINT FINAL FLOW FIELD DATA
            WRITE(6,5007)
 5007 FORMAT(1H1,10X,16HFINAL FLOW FIELD)
            IF(IPRINT.GT.0)CALL OUTPUT(ACH,ATTACK,YAW)
            STOP" PROGRAM START"
 1000 CONTINUE
            STOP" TAPE READIN ERROR"
            END
```

```
      SUBROUTINE OUTPUT(ACH,ATTACK,YAW)                                  OUTPUT     2
      COMMON NC,MC,K,IPRINT,PINF,DINF,PHIO,PI,RAD,Z,BZZ,GAMMA,HOT2,BMAX, COMST      2
     1S1,S2,C1,C2,CONVR,PTINF,                                           COMST      3
     1 C(100),CZ(100),CPHI(100),R(25,100),D(25,100),P(25,100),U(25,100), COMST      4
     1 V(25,100),W(25,100),PHI(100)                                      COMST      5
     2 ,BNEW(100),CNEW(100),DUMV(26),DUMP(26),DUMU(26),DUMW(26),DUMD(26) COMST      6
     3 ,BZNEW(100),BPHNEW(100),CZNEW(100),CPHNEW(100),ROLD(26)           COMST      7
     4  ,PTR(25,100),RCLUST(100),PHIL(102)                               COMST      8
      COMMON/RGASS/AX,HX,GX                                              RGASS      2
      WRITE (6,3000) ACH,ATTACK,YAW                                      OUTPUT     5
 3000 FORMAT(* MACH NO IS*,1PE15.7,5X,*ANGLE OF ATTACK IS*,1PE15.7,5X,   OUTPUT     6
     1  * ANGLE OF SIDESLIP IS*,1PE15.7)                                 OUTPUT     7
      DO 100 M=1,MC                                                      OUTPUT     8
       PHID=PHI(M)*CONVR                                                 OUTPUT     9
         WRITE (6,3010) M,PHID                                           OUTPUT    10
 3010    FORMAT(*0PLANE*I4*   ANGLE IS*F7.2* DEGREES*)                   OUTPUT    11
         WRITE (6,3600) K,Z,BNEW(M),BZNEW(M),BPHNEW(M),CNEW(M),          OUTPUT    12
     1     CZNEW(M),CPHNEW(M)                                            OUTPUT    13
 3600    FORMAT(/* STATION*I5,4X*Z IS*1PE15.7,4X*B IS*1PE15.7,4X*BZ IS*  OUTPUT    14
     1     1PE15.7,4X*BPHI IS*1PE15.7/7X*C IS*1PE15.7,4X*CZ IS*1PE15.7,  OUTPUT    15
     1     4X,*CPHI IS*1PE15.7)                                          OUTPUT    16
         WRITE (6,3700)                                                  OUTPUT    17
 3700    FORMAT (/7X*R*12X*W*12X*U*12X*V*12X*P*10X*PT/PT0*8X*RHO*11X,    OUTPUT    18
     1   *S*,12X,*M*)                                                    OUTPUT    19
         DO 90 N=1,NC                                                    OUTPUT    20
           L=NC-N+1                                                      OUTPUT    21
           IF(P(L,M).GT.0..AND.D(L,M).GT.0.) GO TO 80                    OUTPUT    22
           AMACH=SX=XINDEF                                               OUTPUT    23
           GO TO 85                                                      OUTPUT    24
   80      CALL RGAS(P(L,M),D(L,M),SX)                                   OUTPUT    25
           AMACH=SQRT(U(L,M)**2+V(L,M)**2+W(L,M)**2)/AX                  OUTPUT    26
   85     CONTINUE                                                       OUTPUT    27
      PTRL=P(L,M)*(1.+.5*(GAMMA-1.)*AMACH**2)**(GAMMA/(GAMMA-1.))/PTINF  OUTPUT    28
           WRITE (6,3400) R(L,M),W(L,M),U(L,M),V(L,M),P(L,M),PTRL,       OUTPUT    29
     1       D(L,M),SX,AMACH                                             OUTPUT    30
 3400      FORMAT(1P9E13.4)                                              OUTPUT    31
   90    CONTINUE                                                        OUTPUT    32
  100 CONTINUE                                                           OUTPUT    33
      RETURN                                                             OUTPUT    34
      END                                                                OUTPUT    35
```

```
      SUBROUTINE RGAS (PX,RX,SX)                                         PGAS       2
      COMMON/RGASS/AX,HX,GX                                              RGASS      2
C   SHORTENED VERSION OF RGAS TO COMPUTE ONLY PERFECT GAS PROPERTIES     PGAS       4
C     PX=PRESSURE  RX=DENSITY  SX=ENTROPY                                PGAS       5
C       HX=ENTHALPY  AX=SOUND SPEED                                      PGAS       6
      SX = ALOG(PX) - GX * ALOG(RX)                                      PGAS       7
      HX=PX/RX*(1.+1./(GX-1.))                                           PGAS       8
      AX=SQRT(GX*PX/RX)                                                  PGAS       9
      RETURN                                                             PGAS      10
      END                                                                PGAS      11
```

```
                                                                         JUMPST     2
      SUBROUTINE JUMPST(DBP,DBZ,MB,NN,RR,ETAP,SIP,POM)                   JUMPST     3
C      JUMPST COMPUTES JUMPS CORRESPONDING TO DISCONTINUITIES IN BZ      JUMPST     4
C      AND/OR BPHI FOR PERFECT GAS ONLY.                                 JUMPST     5
C                                                                        JUMPST     6
      COMMON NC,MC,K,IPRINT,PINF,DINF,PHIO,PI,RAD,Z,BZZ,GAMMA,HOT2,BMAX, COMST      2
     1S1,S2,C1,C2,CONVR,PTINF,                                           COMST      3
     1 C(100),CZ(100),CPHI(100),R(25,100),D(25,100),P(25,100),U(25,100), COMST      4
     1 V(25,100),W(25,100),PHI(100)                                      COMST      5
     2 ,BNEW(100),CNEW(100),DUMV(26),DUMP(26),DUMU(26),DUMW(26),DUMD(26) COMST      6
     3 ,BZNEW(100),BPHNEW(100),CZNEW(100),CPHNEW(100),ROLD(26)           COMST      7
     4  ,PTR(25,100),RCLUST(100),PHIL(102)                               COMST      8
      COMMON/RGASS/AX,HX,GX                                              RGASS      2
      DATA (INT=18)                                                      JUMPST     9
      VW = V(NN,MB)                                                      JUMPST    10
      PW = P(NN,MB)                                                      JUMPST    11
      DW = D(NN,MB)                                                      JUMPST    12
      WW = W(NN,MB)                                                      JUMPST    13
      UW=U(NN,MB)                                                        JUMPST    14
      CALL RGAS(PW,DW,SW)                                                JUMPST    15
      ASQW=AX*AX                                                         JUMPST    16
      PHID=PHI(MB)/RAD                                                   JUMPST    17
      IF(IPRINT.EQ.3)WRITE (6,3100) NN, PHID, K, Z                       JUMPST    18
 3100 FORMAT (1H0,*JUMP IS CALLED FOR AT RADIAL POINT*,I4,5X,            JUMPST    19
     1    *PHI IS*,F7.2,5X,*K IS*,I4,5X,*Z IS*,1PE15.6)                  JUMPST    20
      IF(IPRINT.EQ.3)WRITE (6,3110)                                      JUMPST    21
 3110 FORMAT(1H ,30X,*THE INPUT VARIABLES ARE AS FOLLOWS*)               JUMPST    22
      IF(IPRINT.EQ.3)WRITE (6,3120) PW,DW,UW,VW,WW,SW,ASQW               JUMPST    23
```

```
    5 THETAR=ACOS(XNMP/(XNP*XNM))
      CONST=HOT2-QT**2
      QSQ=QSM**2
      THETAR=ACOS(ABS(XNMP/(XNP*XNM)))
      THETAD=THETAR/RAD
      AMACH=SQRT(QSQ/ASQW)
      IF (AMMSQ .GE. 1.0) GO TO 10
C   ***   SUBSONIC CORNER FLOW (NO JUMPS IN P,D,S,QSQ)   ***
      QSP=QSM
      GO TO 110
   10 IF (QSM*POM .LT. 0.) GO TO 20
C   ***   SUPERSONIC EXPANSION CORNER   ***
      IF(IPRINT.EQ.3)WRITE (6,3140)
 3140 FORMAT(1H ,20X,*SUPERSONIC EXPANSION CORNER WHERE*)
      IF(IPRINT.EQ.3)WRITE (6,3150) THETAD,AMACH,QT,QSM
 3150 FORMAT(1H ,22HTHETA,AMACH,QT,QSM     ,1P4E15.5)
      CALL RGAS(PW,DW,DUMMY)
      ANG=ASIN(1./AMACH)
      VPOVR=SQRT(ASQW/(CONST-2.*HX-ASQW))
      DEL=THETAR/FLOAT(INT)
      DO 15 I=1,INT
      CC=0.
      PWO=PW
      DWO=DW
   17 DPDAL=-DW*QSQ*VPOVR
      DDDAL=DPDAL/ASQW
      CD=CC+1.
      PW=(PWO+PW*CC+DEL*DPDAL)/CD
      DW=(DWO+DW*CC+DEL*DDDAL)/CD
      CALL RGAS(PW,DW,DUMMY)
      QSQ=CONST-2.*HX
      ASQW=AX*AX
      VPOVR=1./SQRT(QSQ/ASQW-1.0)
      CC=CD
      IF (CC .LT. 1.5) GO TO 17
   15 CONTINUE
      QSP=SQRT(QSQ)
      GO TO 100
C   ***   SUPERSONIC COMPRESSION CORNER             ***
   20 COSTH2=(XNMP/(XNP*XNM))**2
      IF(IPRINT.EQ.3)WRITE (6,3160)
 3160 FORMAT(1H ,20X,*SUPERSONIC COMPRESSION CORNER WHERE*)
      IF(IPRINT.EQ.3)WRITE (6,3150) THETAD,AMACH,QT,QSM
C   ***   (PERFECT GAS OBLIQUE SHOCK RELATIONS)   ***
      SINTH2=1.-COSTH2
      AM4=AMMSQ**2
      AM2=AMMSQ
      C1=-((AM2+2.)/AM2+GAMMA*SINTH2)
      C3=-COSTH2/AM4
      C2=(2.*AM2+1.)/AM4+(.25*(GAMMA+1.)**2+(GAMMA-1.)/AM2)*SINTH2
      DUMM=C1/3.
      A=-C2+DUMM*C1
      SB=C3-(C2-2.*C1**2/9.)*DUMM
      DDUM=SQRT(A/3.)
      DDUM1=2.*DDUM
      TEST=-.5*SB/(DDUM**3)
      IF (TEST .GE. -1.0) GO TO 25
      IF(IPRINT.EQ.3)WRITE (6,3165)
 3165 FORMAT(1H ,20X,*NORMAL SHOCK MODE IS USED*)
      PWO=PW
      T=AM2
      GO TO 45
   25 XX=ACOS(TEST)/3.
      X1=COS(XX)
      X2=COS(XX+2.*PI/3.)
      X3=COS(XX+4.*PI/3.)
      IF (X1 .LT. X2) GO TO 30
      XDUM=X1
      X1=X2
      X2=XDUM
   30 IF (X1 .LE. X3) GO TO 35
      SX=X1
      GO TO 40
   35 IF (X3 .LE. X2) X2=X3
      SX=X2
   40 SINTH2=DDUM1*SX-DUMM
      ANG=ASIN(SQRT(SINTH2))
      T=AM2*SINTH2
      IF(IPRINT.EQ.3)WRITE (6 , 4007) SINTH2
 4007 FORMAT (10X, * SINTH2 = *, 1PE25.14)
   45 GA2=2.*GAMMA/(GAMMA-1.)
      GD=(GAMMA-1.)/2.
      GE=GD+1.
```

```
      G9=GE/GD                                                          JUMPST   136
      PW=PW*((GA2*T-1.)/G9)                                             JUMPST   137
      DW=DW*(T/(T/G9+1./GE))                                            JUMPST   138
      QSP=QSM*SQRT(1.-(T-1.0)*(GAMMA*T+1.)/(T*AM2*GE**2))               JUMPST   139
      CALL RGAS(PW,DW,SW)                                               JUMPST   140
      ASQW=AX*AX                                                        JUMPST   141
      IF (TEST .GE. -1.0) GO TO 100                                     JUMPST   142
      CONST=ASQW/(GAMMA-1.0)+.5*QSP**2                                  JUMPST   143
      PW=PW*SINTH2                                                      JUMPST   144
      IF (PW .GT. PWO) GO TO 75                                         JUMPST   145
      PW=PWO                                                            JUMPST   146
   75 CALL RGAS(PW,DW,SW)                                               JUMPST   147
      ASQW=AX*AX                                                        JUMPST   148
      QSP=-SQRT(2.*(CONST-HX))                                          JUMPST   149
  100 D(NN,MB)=DW                                                       JUMPST   150
      P(NN,MB)=PW                                                       JUMPST   151
  110 AA1=QT/XT                                                         JUMPST   152
      AA2=QSP*POM/(DUM*XNP)                                             JUMPST   153
      V(NN,MB)=AA2*(XNP2*SIM-XNMP*SIP)-AA1*DBZ                          JUMPST   154
      U(NN,MB)=ABS(AA1*XT2+AA2*(XNMP-XNP2))                             JUMPST   155
      W(NN,MB)=ABS(AA1*DBP+AA2*(XNP2*ETAM-XNMP*ETAP))                   JUMPST   156
      IF(IPRINT.EQ.3)WRITE (6,3170)                                     JUMPST   157
 3170 FORMAT(1H ,30X,*THE OUTPUT VARIABLES ARE AS FOLLOWS*)             JUMPST   158
      IF(IPRINT.EQ.3)WRITE(6,3120)PW,DW,U(NN,MB),V(NN,MB),W(NN,MB),SW,  JUMPST   159
     1   ASQW                                                           JUMPST   160
      POM=ANG                                                           JUMPST   161
      RETURN                                                            JUMPST   162
      END                                                               JUMPST   163
```

APPENDIX B. LISTING OF SWINT CHANGES

The modifications extending SWINT to handle inlets are given in CDC update form in this section. The listing contains directive cards *DELETE, *INSERT and *BEFORE which describe where changes are to be inserted. The directive cards identify cards in SWINT using the right hand column designators provided in Appendix B of Reference 2. The directive cards are interpreted as follows:

1. *DELETE DECK.n,DECK2.m . The cards in SWINT located between and including DECK.n and DECK2.m are deleted. The cards in the update listing occurring between this *DELETE card and the next directive card are inserted in place of the deleted cards.

2. *INSERT DECK.m . The cards in the update listing lying between this *INSERT card and the next directive are inserted following the card in the SWINT deck with identifier DECK.m .

3. *BEFORE DECK.n . The cards in the update listing lying between this *BEFORE card and the next directive are inserted before the card in SWINT with the identifier DECK.n .

The listing provided in this section also contains *CALL NAME and *DECK cards. At the location in SWINT where *CALL NAME is added, the labeled common NAME should appear. *DECK cards can be disregarded.

The update listing contains the three new subroutines COWL,COWLP and WALL2. The functions of these subroutines are analogous to those of BODY,BODYP and WALL, but apply to the cowl surface rather than the inner body surface.

```
*IDENT COWLADD
*I CCONST.5
*COMDECK CCOWL
      COMMON /CCOWL/
     1   C(25), CO(25), CPHI(25), CPHIO(25), CPHPHI(25), CPHPHO(25),
     2   CZ(25), CZO(25), CZPHI(25), CZPHIO(25), CZZ(25), CZZO(25),           COMMON CCOWL
     3   C2M(25), C3M(25), C4M(25), C5M(25), C7M(25), ICOWL,                    (new)
     4   ICOWOPT, IJMPKTC(25), IJUMPC(25), IJUMPIC(25),
     5   PZCORC(25), SC(25),
     6   C3(3), C4(3), C5(3), C7(3),
     7   PCY(3), SCY(3), VOCY(3), V2C(3)
C
*DELETE CSWINT.4
     2   ASQ(20,25), DET(20,25),
*INSERT COOPT.5
     4   , ISWMODC, ISWSHOC, MODIC
*D SWINT.3
     1   TAPE3=512, TAPE9, TAPE16, TAPE17=512, TAPE20, TAPE22=512
     2   , TAPE23, TAPE24)
*INSERT SWINT.10
*CALL CCOWL
*INSERT SWINT.31
      IF (ICOWL .EQ. 1) CALL COWL (-1)
*INSERT SWINT.82
        IF (ICOWL .EQ. 1) CALL WALL2 (0, M, MP, MM, KN,
     $     CUP(1,NC,M), CUP(2,NC,M), CUP(3,NC,M))
*INSERT SWINT.92
         IF (ICOWL .EQ. 1) GO TO 10
*INSERT SWINT.108
      IF (ICOWL .EQ. 1) CALL COWL (0)
*INSERT SWINT.110
        IF (ICOWL .EQ. 1) GO TO 60                                            SUBROUTINE SWINT
*INSERT SWINT.163
        IF (ICOWL .EQ. 0) GO TO 54
C.....ADVANCE COWL POINT.
        CALL WALL2 (1, M, MP, MM, KN, PZS, SZS, V2S)
        CU(1,NC,M) = 0.5 * (CU(1,NC,M) + CUP(1,NC,M) + DZ * PZS)
        CU(2,NC,M) = 0.5 * (CU(2,NC,M) + CUP(2,NC,M) + DZ * SZS)
        CU(3,NC,M) = 0.5 * (CU(3,NC,M) + CUP(3,NC,M) + DZ * V2S)
   54   CONTINUE
*INSERT SWINT.171
         IF (ICOWL .EQ. 1) GO TO 40
*DELETE SWINT.193
          CALL JUMP (M, 1)
*INSERT SWINT.198
      DO 48 M = 1 , MP2
         IF (IJUMPC(M) .EQ. 0) GO TO 48
         IF (M .EQ. MP2O) GO TO 48
         CALL COWLP (M, 1)
C...COWL JUMP.
         CALL JUMP (M, NC)
   48 CONTINUE
*I CORNER.59
*DECK COWL
      SUBROUTINE COWL (JC)
C*********************************************************************
C
C     THIS ROUTINE COMPUTES THE COWL RADIUS AND DERIVATIVES AT ALL PHI
C     PLANES FOR A GIVEN Z.  COWLP IS THEN CALLED TO DETERMINE
C     NECESSARY COWL SHAPE CONSTANTS AND TO CHECK FOR A JUMP.  AT THE
C     COMPLETION OF COWL, THE COWL RADIUS AND DERIVATIVES ARE STORED IN
C     C(M),CZ(M),ETC.  OLD VALUES AT Z - DZ ARE STORED IN CO(M) CZO(M),
C     ETC.FOR ANY PLANE ON WHICH A JUMP OCCURS,NEW AND OLD VALUES ARE
C     STORED IN REVERSE ORDER.
C     NOTE THAT Z IS ASSUMED TO BE INCREASING.
C     SUBROUTINE MUST BE VALID ON FRINGE PLANES.
C
C*********************************************************************
*CALL CBODY
*CALL CCONST
*CALL CCOWL
      DO 50 M=1,MP2  <-- COWLADD.56                                           SUBROUTINE COWL
C                                                                               (new)
C.....TRANSFER NEW VALUES TO OLD
      CO(M)=C(M)
      CZO(M)=CZ(M)
      CPHIO(M)=CPHI(M)
      CPHPHO(M)=CPHPHI(M)
      CZPHIO(M)=CZPHI(M)
      CZZO(M)=CZZ(M)
C
      C(M) = 0.0
      CZ(M) = 0.0
      CPHI(M) = 0.0
```

```
      CPHPHI(M) = 0.0
      CZPHI(M) = 0.0
      CZZ(M) = 0.0
C
C*****INSERT DEFINITIONS OF C, CZ, CPHI, CPHPHI, CZPHI, AND CZZ BELOW.
C
C
      CALL COWLP(M,JC)
   50 CONTINUE
      RETURN
      END
*DECK COWLP
      SUBROUTINE COWLP (M, JC)
C
C     COWLP COMPUTES COWL PARAMETERS AND CHECKS FOR COWL JUMP.
C     INPUT - M - M-PLANE NUMBER
C             JC =  0 CHECK FOR JUMP AND COMPUTE COWL PARAMETERS
C             JC = -1 COMPUTES COWL PARAMETERS ONLY
C             JC =  1 REVERSE NEW AND OLD COWL DESCRIPTION AND
C                     COMPUTES COWL PARAMETERS
C
*CALL CBODY
*CALL CCONST
*CALL CCOWL
*CALL CSTEPS
*CALL CXXYYZZ
C     INITIALIZE JUMP AND INLET KEY
C
      IF (JC) 140, 10, 80
C     CHECK FOR A JUMP.
   10 CONTINUE
      CZZC = CZZ(M) - YZM(M) * CZPHI(M) / YPHIM(M)
      CZZOC = CZZO(M) - YZM(M) * CZPHI(M) / YPHIM(M)
      TEST1 = AMAX1 (ABS(CZZC), ABS(CZZOC))
      TEST1=ABS(CZ(M)-CZO(M))-DZ*TEST1
      TEST2=AMAX1(ABS(CZPHI(M)),ABS(CZPHIO(M)))
      TEST2=ABS(CPHI(M)-CPHIO(M))-DZ*TEST2
      IF(TEST1.GT.1.E-6)GO TO 30
      IF(TEST2 .GE. 1.E-6) GO TO 30
      IJUMPC(M)=0
      GO TO 140
C.....JUMP OCCURS-CHECK FOR OVERIDE
   30 CONTINUE
        IJUMPC(M)=1
      IF(PHI(M).GE.PHI2J)GO TO 80
      IF(PHI(M).LE.PHI1J)GO TO 80
C.....NO JUMP
      ICFL = 1
      IJUMP1C(M)=2
        IJUMPC(M)=0
      GO TO 140
   80 CONTINUE
      XK=CZ(M)
      CZ(M)=CZO(M)
      CZO(M)=XK
      XK=CPHI(M)
      CPHI(M)=CPHIO(M)
      CPHIO(M)=XK
      XK=CZPHI(M)
      CZPHI(M)=CZPHIO(M)
      CZPHIO(M)=XK
      XK=CZZ(M)
      CZZ(M)=CZZO(M)
      CZZO(M)=XK
      XK=CPHPHI(M)
      CPHPHI(M)=CPHPHO(M)
      CPHPHO(M)=XK
C.....COMPUTE COWL SHAPE PARAMETERS
  140 CONTINUE
      CM=C(M)
      CZM=CZ(M)
      PHIZ=-YZM(M)/YPHIM(M)
      CPOB = CPHI(M) / CM
      CPOB2 = CPOB ** 2
      DUM = 1.0 + CZM ** 2
      C22=DUM+CPOB2
      DUM1=(CPHPHI(M)/CM-CPOB2)
      DUM2=(CZZ(M)+CZPHI(M)*PHIZ)/DUM
      DUM3=CZPHI(M)/CM
      DUM4=DUM3-CZM*CPOB/CM
      C2M(M)=SQRT(C22)
      C3M(M)=DUM1/YPHIM(M)
```

COWLADD.73

SUBROUTINE COWL (new)

SUBROUTINE COWLP (new)

```
      C4M(M)=DUM4+PHIZ*DUM1
      C5M(M)=CZPHI(M)/YPHIM(M)
      C7M(M)=DUM2*DUM
      RETURN
      END
```

SUBROUTINE COWLP
(new)

```
*INSERT DECODE.16
*CALL CCOWL
*INSERT DECODE.115
      IF (ICOWL .EQ. 0) GO TO 2006
C
C...DECODE COWL POINT.
C
      U3 = CV(3,NC,M)
      SCM = CV(2,NC,M)
      SC(M) = SCM
      T1 = CZ(M)
      T2 = CPHI(M) / C(M)
      T3 = 1.0 + T2 ** 2
      PM = EXP (CV(1,NC,M))
      IF (CV(1,NC,M) .GT. -600.0 .AND. CV(1,NC,M) .LT. 700.0) GO TO 2002
      WRITE (6 , 3457) M, PM
      CALL SAVE
 2002 CONTINUE
      P(NC,M) = PM
      CALL RGAS (PM, DM, SCM, 5)
      D(NC,M) = DM
      ASQ(NC,M) = AX * AX
      QSQ = HOT2 - 2.0 * HX
      CDUMP = QSQ * T3 - U3 * U3
      IF (CDUMP .GE. 0.0) GO TO 2003
      CALL DMPSQRT (6HDECODE, 5, Z, K, M, NC, CDUMP)
 2003 CONTINUE
      WM = SQRT (CDUMP) / C2M(M)
      W(NC,M) = WM
      V(NC,M) = (U3 - T2 * T1 * WM) / T3
      U(NC,M) = T1 * WM + T2 * V(NC,M)
      GO TO 9
 2006 CONTINUE
*INSERT DECODE.233
      IF (ICOWL .EQ. 1) GO TO 100
*INSERT DECODE.236
  100 CONTINUE
*INSERT DECODE.246
 3457 FORMAT (1H1, * IN SUBROUTINE DECODE THE LOG OF PRESSURE ON PLANE*,
     $   I4, * ON THE COWL IS *, 1PE15.6, 5X, *---   STOP   ---*)
```

SUBROUTINE DECODE

```
*INSERT EVAL.15
*CALL CCOWL
*INSERT EVAL.29
      IF (ICOWL .EQ. 0) GO TO 15
      C3(KF) = C3M(M)
      C4(KF) = C4M(M)
      C5(KF) = C5M(M)
      C7(KF) = C7M(M)
   15 CONTINUE
*INSERT EVAL.101
      IF (N .LT. NC .OR. ICOWL .EQ. 0) GO TO 26
      PCY(KF) = PNM
      VOCY(KF) = VNM / WNM
      SCY(KF) = SC(M)
      V2C(KF) = VNM + CPHI(M) * UNM / C(M)
   26 CONTINUE
```

SUBROUTINE EVAL

```
*INSERT FIELD.15
*CALL CCOWL
*CALL CDECODE
*INSERT FIELD.74
      GA=GA2*.5
      PTM = (1.0 + GD * ACH**2.0) ** (-GA)
      IF(ICOWL.EQ.0)GO TO 40
      PTRTOT = 0.0
      AREAT = 0.0
C.....PRESSURE RECOVERY CALCULATED
C.....PTR IS LOCAL TOTAL PRESSURE RATIO
C.....PRESSURE RECOVERY = SUM (PTR * LOCAL AFFECTED AREA) / TOTAL AREA
      DO 111 M = 2, MP1
           IM1 = 1
           IMC = 1
           IF ((1-IDYAW)*M .EQ. 2) IM1 = 0
           IF ((1-IDYAW)*M .EQ. MP1) IMC = 0
           DO 110 N = 1, NC
              AX = SQRT(GAMMA * P(N,M)/D(N,M))
              AMACH = SQRT(U(N,M)**2.0 + V(N,M)**2.0 + W(N,M)**2.0) / AX
              PTR = P(N,M) * PTM * (1.0 + GD * AMACH**2)**GA
```

SUBROUTINE FIELD

SUBROUTINE FIELD

```
            IN1 = 1
            INC = 1
            IF (N .EQ. 1) IN1 = 0
            IF (N .EQ. NC) INC = 0
            AREA = 0.25 * (PHI(M+INC)-PHI(M-IM1)) * ((0.5*(R(N,M)+
     1        R(N+INC,M)))**2.0 - (0.5*(R(N-IN1,M)+R(N,M)))**2.0)
            AREAT = AREAT + AREA
            PTRTOT = PTRTOT + PTR * AREA
  110     CONTINUE
  111 CONTINUE
      PR = PTRTOT / AREAT
      WRITE (6,3005) PR
   40 CONTINUE
*INSERT FIELD.84
      PTR=XINDEF
*I FIELD.88
      PTR=P(L,M)*PTM*(1.+GD*AMACH**2)**GA
*DELETE FIELD.99
*DELETE FIELD.100
      WRITE(6,3400)L,R(L,M),W(L,M),U(L,M),V(L,M),P(L,M),PTR,
     1   D(L,M),SX,AMACH,TR1,TZ1,ISX
*INSERT FIELD.114
      PTR=XINDEF
*INSERT FIELD.118
      PTR=P(L,MM)*PTM*(1.+GD*AMACH**2)**GA
*DELETE FIELD.120
*DELETE FIELD.121
      WRITE(6,3400)L,R(L,MM),W(L,MM),U(L,MM),V(L,MM),P(L,MM),
     1   PTR,D(L,MM),SX,AMACH,THR(ICF,L),THZ(ICF,L),IS(ICF,L)
*INSERT FIELD.129
 3005 FORMAT (*0*,*PRESSURE RECOVERY   PTAVR/PTINF = *,F10.5)
*DELETE FIELD.131
 3400 FORMAT(* *,I2,1X,3(1PE11.4,1X),1P8E11.4,1X,I4)
*DELETE FIELD.136
*DELETE FIELD.137
 3700 FORMAT(*0 N *,6X,1HR,11X,1HW,11X,1HU,11X,1HV,10X,1HP,7X,8HPT/PTINF,
     1   6X,3HRHO,9X,1HS,10X,1HM,10X,2HTR,9X,2HTZ,5X,2HIS)
```

SUBROUTINE FINAD

```
*INSERT FINAD.15
*CALL CCOWL
*INSERT FINAD.87
      IF (ICOWL .EQ. 1) CALL WALL2 (0, M2, MP, MM, KN,
     $   CUP(1,NC,M2), CUP(2,NC,M2), CUP(3,NC,M2))
*INSERT FINAD.117
      IF (ICOWL .EQ. 1) GO TO 35
*INSERT FINAD.199
      IF (ICOWL .EQ. 0) GO TO 61
      CALL WALL2 (1, M2, MP, MM, KN, PS, SS, VS)
      CU(1,NC,M2) = 0.5 * (CU(1,NC,M2) + CUP(1,NC,M2) + PS * DZ)
      CU(2,NC,M2) = 0.5 * (CU(2,NC,M2) + CUP(2,NC,M2) + SS * DZ)
      CU(3,NC,M2) = 0.5 * (CU(3,NC,M2) + CUP(3,NC,M2) + VS * DZ)
   61 CONTINUE
*INSERT FINAD.231
      IF (ICOWL .EQ. 1) GO TO 70
```

SUBROUTINE FRINGE

```
*INSERT FRINGE.10
*CALL CCOWL
*BEFORE FRINGE.19
      IF (ICOWL .EQ. 0) GO TO 93
      CPMPHI(M1) = CPMPHI(M2)
      CZZ(M1) = CZZ(M2)
      CZPHI(M1) = CZPHI(M2)
      SC(M1) = SC(M2)
   93 CONTINUE
```

SUBROUTINE INIT

```
*INSERT INIT.6
*CALL CCOWL
*INSERT INIT.83
      IF (ICOWL .EQ. 0) GO TO 42
        SC(M) = SFF
        CU(1,NC,M) = ALOG (P(NC,M))
        CU(2,NC,M) = SC(M)
        CU(3,NC,M) = V(NC,M) + U(NC,M) * CPHI(M) / C(M)
        GO TO 43
   42   CONTINUE
*INSERT INIT.86
   43   CONTINUE
*INSERT INIT.99
        IJUMPC(M) = 0
      IF (ICOWOPT .EQ. 1) GO TO 33
        IJUMP1C(M) = 0
        IJMPKTC(M) = 0
      GO TO 34
   33 CONTINUE
      IJUMP1C(M) = 4
      IJMPKTC(M) = 1
```

SUBROUTINE INIT

SUBROUTINE INLET

SUBROUTINE INTEG

```
   34 CONTINUE
*INSERT INLET.14
*CALL CCOWL
*DELETE INLET.70
      WRITE (6, 1000)
 1000 FORMAT (* INLET SUBROUTINE CALLED *)
      CALL JUMP (M, 1)
*INSERT INTEG.14
*CALL CCOWL
*INSERT INTEG.112
C
      IF (ICOWL .EQ. 0) GO TO 1600
C
C...INTEGRATE THE COWL PRESSURES.
C
      K1=1
      DO 1325 I=1,6
      SSF(I)=0.
      SUMJ(I,1)=0.
      SUMJ(I,2)=0.
 1325 CONTINUE
C
      IF (IDYAW .EQ. 1) GO TO 1300
C   ***   SIMPSON"S RULE FOR SYMMETRY CASE (PHIO=180)    ***
      DO 1200 M=2,MC
      CM = C(M)
      CPHIB = CPHI(M) / CM
      DUM = -2.0 * (P(NC,M) - PINF) * CM * PHIO * TG4M(M)
      SINP = SINPHI(M)
      COSP = COSPHI(M)
      SF(1)=DUM*(COSP+CPHIB*SINP)
      SF(3)=DUM*CZ(M)
      DUM1=SF(3)*CM
      SF(2)=DUM1*COSP
      IF(M.NE.3)GO TO 1125
      SF1(1) = SUMJ(1,1)
      SF1(2) = SUMJ(2,1)
      SF1(3) = SUMJ(3,1)
 1125 DO 1150 I=1,3
 1150 SUMJ(I,K1)=SUMJ(I,K1)+SF(I)
      K1=3-K1
 1200 CONTINUE
      SF2(1)=2.*(P(NC,MP1)-PINF)*C(MP1)*PHIO*TG4M(MP1)
      SF2(3)=-SF2(1)*CZ(MP1)
      SF2(2)=-SF2(3)*C(MP1)
      DO 1250 I=1,3
      F(I)=DYD3*(4.*SUMJ(I,2)+2.*SUMJ(I,1))-SSF(I)+F(I)
      IF (K1 .EQ. 1) GO TO 1225
C.....EVEN NUMBER OF POINTS-USE SIMPSONS RULE FROM M=2 TO MC.
C     APPROXIMATE THE LAST INTERVAL USING TRAPEZOIDAL INTEGRATION.
      F(I)=F(I)+DYD3*(.5*SF(I)-SF1(I)+1.5*SF2(I))
      GO TO 1250
 1225 F(I)=F(I)+DYD3*(SF2(I)-SF1(I))
C.....ODD NUMBER OF POINTS- APPLY SIMPSONS RULE DIRECTLY.
 1250 CONTINUE
      GO TO 1600
C   ***   SIMPSON"S RULE FOR NON-SYMMETRIC CASE (PHIO=360)    ***
 1300 CONTINUE
      K1=1
      DO 1500 M=2,MP1
      CM = C(M)
      CPHIB = CPHI(M) / CM
      DUM=-(P(NC,M)-PINF)*CM*PHIO*TG4M(M)
      SINP = SINPHI(M)
      COSP = COSPHI(M)
      SF(1)=DUM*(COSP+CPHIB*SINP)
      SF(3) = DUM * CZ(M)
      DUM1 = SF(3) * CM
      SF(2) = DUM1 * COSP
      SF(4) = DUM1 * SINP
      SF(5)=DUM*(CPHIB*COSP-SINP)
      SF(6)=DUM*CM*CPHIB
      IF(M.NE.3)GO TO 1375
      DO 1350 I=1,6
      SF1(I) = SUMJ(I,1)
      SF2(I) = SF(I)
 1350 CONTINUE
 1375 DO 1400 I=1,6
 1400 SUMJ(I,K1)=SUMJ(I,K1)+SF(I)
      K1=3-K1
 1500 CONTINUE
      DO 1525 I=1,6
      F(I)=DYD3*(4.*SUMJ(I,2)+2.*SUMJ(I,1))-SSF(I)+F(I)
```

```
C.....ODD NUMBER OF POINTS-APPLY SIMPSONS RULE DIRECTLY.
      IF (K1 .EQ. 1) GO TO 1525
C.....EVEN NUMBER OF POINTS-APPLY SIMPSON RULE FROM M=2 TO MP1 AND
C     EXTEND TO M=3. USE TRAPEZOIDAL RULE TO SUBTRACT M=2 TO 3 INTERVAL.
      F(I)=F(I)+DYD3*(4.*SF1(I)-SF2(I)-2.*SF(I))
 1525 CONTINUE
C
 1600 CONTINUE
*DELETE JUMP.2
      SUBROUTINE JUMP (MB, N)
*INSERT JUMP.16
*CALL CCOWL
*DELETE JUMP.24,JUMP.26
      SO = SW(MB)
      POM = 1.0
      ETAP = BZ(MB)
      SIP = BPHI(MB) / B(MB)
      IF (N .EQ. 1) GO TO 40
C...COWL SURFACE.
      DBP = CPHIO(MB) / CO(MB) - CPHI(MB) / C(MB)
      DBZ = CZO(MB) - CZ(MB)
      SO = SC(MB)
      IF (N .EQ. 1) WRITE(JJJJJ,3130)B(MB),BZ(MB),BPHI(MB),DBP,DBZ,HOT2
      IF (N .GT. 1) WRITE(JJJJJ,3131)C(MB),CZ(MB),CPHI(MB),DBP,DBZ,HOT2
      POM = -1.0
      ETAP = CZ(MB)
      SIP = CPHI(MB) / C(MB)
   40 CONTINUE
      UW = U(N,MB)
      VW = V(N,MB)
      WW = W(N,MB)
      PW = P(N,MB)
      DW = D(N,MB)
      ASQW = ASQ(N,MB)
*DELETE JUMP.32
*DELETE JUMP.49
      IF (N .EQ. 1) IJUMP1(MB) = 2
      IF (N .GT. 1) IJUMP1C(MB) = 2
*DELETE JUMP.55
      IF (N .EQ. 1) IJUMP1(MB) = 2
      IF (N .GT. 1) IJUMP1C(MB) = 2
*DELETE JUMP.57
   10 CONTINUE
      IF (QSM*POM .LT. 0.0) GO TO 20
*DELETE JUMP.62
      ICFL = 1
      IF (N .GT. 1) GO TO 15
      IJUMP1(MB) = 3
      IJMPKT(MB) = 1
      GO TO 100
   15 CONTINUE
      IJUMP1C(MB) = 3
      IJMPKTC(MB) = 1
*DELETE JUMP.66,JUMP.68
      IF (N .GT. 1) GO TO 22
      IJUMP1(MB) = 4
      IJMPKT(MB) = 1
      GO TO 23
   22 CONTINUE
      IJUMP1C(MB) = 4
      IJMPKTC(MB) = 1
   23 CONTINUE
      CALL COMP (THETAR, AMACH, PW, DW, SO, QSM, QSP, QT, ASQW, XUK)
  100 CONTINUE
      D(N,MB) = DW
      P(N,MB) = PW
      ASQ(N,MB) = ASQW
*DELETE JUMP.70,JUMP.72
      IF (N .EQ. 1) SW(MB) = SO
      IF (N .GT. 1) SC(MB) = SO
      V(N,MB) = AA2 * (XNP2 * SIM - XNMP * SIP) - AA1 * DBZ
      U(N,MB) = AA1 * XT2 + AA2 * (XNMP - XNP2)
      W(N,MB) = AA1 * DBP + AA2 * (XNP2 * ETAM - XNMP * ETAP)
*DELETE JUMP.74,JUMP.77
      WRITE (JJJJJ,3120) PW,DW,U(N,MB),V(N,MB),W(N,MB),SO,ASQ(N,MB)
      CU(1,N,MB) = ALOG (P(N,MB))
      CU(2,N,MB) = SO
      CU(3,N,MB) = V(N,MB) + SIP * U(N,MB)
*INSERT JUMP.84
 3131 FORMAT (1H ,22HC,CZ,CPHI,DBP,DBZ,HOT2,1P6E15.5)
```

SUBROUTINE INTEG

SUBROUTINE JUMP

```
*INSERT OUT.8
*CALL CCOWL
*INSERT OUT.61
      WRITE (23) Z, MP2M1, (PB(M), M=1,MP2M1)
*INSERT OUT.71
      IF (ICOWL .EQ. 0) GO TO 850
C
C...THIS SECTION OUTPUTS PRESSURES AT THE COWL.
C
      REWIND 16
      NPTS = 0
      M1 = 1
      MCMX = MC
      M1P14 = M1 + 14
  725 CONTINUE
      NPTS = NPTS + 1
  730 CONTINUE
      MCS = MC
      READ (16) NC,MC,ATTA,YAW,ACH,GAMMA,PINF,DINF,PHIO,K,Z,
     1   (DUM, I=1,12), (PHI(M), DUM, DUM, DUM, M=1,MP2M1),
     2   ((DUM, DUM, DUM, DUM, PB(M), DUM, M=1,MP2M1), N=1,NC)
      IF (EOF (16)) 840, 750
  750 CONTINUE
      M2 = MINO (MC, M1P14)
      IF (M2 .LT. M1) GO TO 730
      IF (MC .NE. MCS) NPTS = 1
      IF (MOD (NPTS-1, 53) .NE. 0) GO TO 775
      WRITE (6, 3000) ACH, ATTA, YAW, Z0
      IF (IPCID .EQ. 0) WRITE (6 , 3520)
      IF (IPCID .NE. 0) WRITE (6 , 3525)
      DO 760 M = M1 , M2
         PHI(M) = PHI(M) / RAD
  760 CONTINUE
      WRITE (6 , 3030) (PHI(M), M=M1,M2)
      WRITE (6 , 3040)
  775 CONTINUE
      DO 762 M = M1 , M2
         PB(M) = PB(M) / PINF
  762 CONTINUE
      ZZ = Z + Z0
      IF (IPCID .EQ. 1) GO TO 800
      WRITE (6 , 3050) ZZ, (PB(M), M=M1,M2)
      GO TO 825
  800 CONTINUE
      DO 810 M = M1 , M2
         PB(M) = (PB(M) - 1.0) / CONT1
  810 CONTINUE
      WRITE (6 , 3055) ZZ, (PB(M), M=M1,M2)
  825 CONTINUE
      IF (M1 .GT. 1) GO TO 725
      MCMX = MAX0 (MC, MCMX)
      WRITE (24) Z, MP2M1, (PB(M), M=1,MP2M1)
      GO TO 725
  840 CONTINUE
      M1 = M1 + 15
      IF (M1 .GT. MCMX) GO TO 850
      M1P14 = M1 + 14
      NPTS = 0
      REWIND 16
      GO TO 725
C*****************************************************************
  850 CONTINUE
*INSERT OUT.262
 3520 FORMAT (1H0,35X,*C O W L   P R E S S U R E   R A T I O *)
 3525 FORMAT (1H0,30X,*C O W L   P R E S S U R E   *,
     +    *C O E F F I C I E N T*)
*BEFORE PRINTST.19
*CALL CCOWL
*DELETE PRINTST.26
     1    ICOWL, NSFD, NSGD
*INSERT PRINTST.33
      IF(ICOWL.EQ.1)WRITE (6 , 5023) ISWSMOC, ISWMODC, MODIC,ICOWOPT
*INSERT PRINTST.94
     8    9X,* ICOWL =  *,I10,10X,*(OUTER BOUNDARY DEFINITION, 1=WALL,0=*
     $          *SHOCK)*,/,
*INSERT PRINTST.157
C
 5023 FORMAT (///, 5X, 4H****, * COWL OPTIONS*, 4H****, //,
     1    9X,* ISWSMOC = *,I6,10X,*(ISWSMOC = 1 -ENTROPY EXTRAPOLATION, =
     $0-STANDARD)*,/,
     2    9X,* ISWMODC = *,I6,10X,*(FORM OF BOUNDARY CONDITIONS- 0 = 14A,
     $15A,  3 = 14C,15C)*,/,
     3    9X,* MODIC = *,I8,10X,*(ORDER OF ACCURACY-- 0=1ST ORDER, 1=2ND
     $ORDER UNTIL COWL DISCONTINUITY ENCOUNTERED)*,/,
```

SUBROUTINE OUT

SUBROUTINE PRINTST

```
     4    9X,* ICOWOPT = *,I6,10X,*(COWL NORMAL DERIVATIVE CONTROL- 0=*
     $         *STANDARD,1=MODIFIED FOR 4 STEPS)*)
*INSERT RADIUS.7
*CALL CCOWL
*DELETE RADIUS.20
      IF  (ICOWL .EQ. 0) CC = CU(1,NC,M) - B(M)
      IF (ICOWL .EQ. 1) CC = C(M) - B(M)
*INSERT READIN.10
*CALL CCOWL
*INSERT READIN.34
     6    , ICOWL, ICOWOPT, ISWMODC, ISWSMOC, MODIC
*INSERT READIN.81
      ICOWL = 0
      ICOWOPT = 0
      ISWMODC = 3
      ISWSMOC = 0
      MODIC = 1
*INSERT READIN.157
      KFAC1 = 1
*INSERT REZONE.16
*CALL CCOWL
*INSERT REZONE.68
      IF (ICOWL .EQ. 1) CALL COWL (-1)
      IF (ICOWL .EQ. 1) GO TO 65
*INSERT REZONE.78
   65 CONTINUE
*INSERT SAVE.10
*CALL CCOWL
*INSERT SHOCK.14
*CALL CCOWL
*INSERT TRANF.17
*CALL CCOWL
*INSERT STEPS.20
C.....AT LAST STEP, MAKE SURE Z=ZEND.
      IF (Z+DZ .LE. ZEND) GO TO 204
      DZ = ZEND - Z
      Z = ZEND
      IF (DZ .LT. 1.E-4) DZ = 1.E-4
      GO TO 205
  204 CONTINUE
*I WALL.140
*DECK WALL2
      SUBROUTINE WALL2(L,M,JR,JL,JSG,PZ,SZ,V2Z)
C
C       WALL2 COMPUTES PREDICTED OR CORRECTED Z DERIVATIVES OF
C       P, V2, AND S(ENTROPY) USING CHARACTERISTIC COMP. RELS.
C       V2 IS VEL. COMP. TANGENT TO COWL      V2=V+(CPHI/B)*U
C       V2C(J), SCY(J), VOCY(J), AND PCY(J) ARE COWL VALUES OF
C      V2, S, V/W AND P RESPECTIVELY.    CONTROL INTEGERS IN ARGUMENT ARE
C         L , =0 FOR PREDICTOR AND 1 FOR CORRECTOR
C         M , Y PLANE
C         JR, STORAGE LOCATION OF RIGHT SIDE DIFFERENCE QUANTITIES
C         JL, STORAGE LOCATION OF LEFT SIDE DIFFERENCE QUANTITIES.
C        JSG, STORAGE LOCATION OF M PLANE FOR DIFFERENCED QUANTITIES.
C       JR AND JL ARE LINE IDENT. INDEXES FOR Y DIFFS.
C       JSG=1,2,3 LINE INDEX FOR TRANG AND COWL PARAMETERS
C       IF=1,2 LINE INDEX FOR TRANF PARAMETERS
C       THIS VERSION OF WALL2 CONTAINS SEVERAL OPTIONS FOR COWL B.C.
C           ISWSMOC NE 0 MEANS COWL ENTROPY EXTRAPOLATION
C           MODIC = 1 MEANS SECOND ORDER ACCURACY
C           ISWMODC = 0 MEANS MOD 0 FOR COWL B.C.
C                   = 3 MEANS MOD 3 FOR COWL B.C.
C       THIS ROUTINE CONTAINS SPECIAL FEATURES AFTER A JUMP
C           IJUMP1C(M) = 0 MEANS NO JUMP ON LINE
C           IJUMP1C(M) NE 0 MEANS JUMP HAS BEEN CALLED (SEE JUMP)
C           IJUMP1C(M) = 2 MEANS NO SECOND ORDER ACCURACY
C                          AND NO ENTROPY EXTRAP. IF A COMPRESSION JUMP
C                          AND MOD 0 FOR COWL B.C.
C
*CALL CSWINT
*CALL CCONST
*CALL CCOWL
*CALL CDECODE
*CALL CDOPT
*CALL CEVAL
*CALL CSHOCK
*CALL CSTEPS
*CALL CTRANF
*CALL CTRANG
*CALL CWALL
*CALL CXXYYZZ
C
      DIMENSION DCGY(4),ICONT(100)
```

SUBROUTINE PRINTST
SUBROUTINE RADIUS
SUBROUTINE READIN
SUBROUTINE REZONE
SUBROUTINE SAVE
SUBROUTINE SHOCK
SUBROUTINE TRANF
SUBROUTINE STEPS
SUBROUTINE WALL2 (new)

```
      DATA ICONT/100*0/
      KMODIC = MODIC
      KSWMOD = ISWMODC
      CM = C(M)
      CZM = CZ(M)
      CPHOB = CPHI(M) / CM
      YPHIJ=YPHI(JSG)
      YZJ=YZ(JSG)
      XRW=XR(NC,JSG)
      UW = U(NC,M)
      WW = W(NC,M)
      PW = P(NC,M)
      VW = V(NC,M)
      DW = D(NC,M)
      ASQW = ASQ(NC,M)
      VOR = VW / CM
      VOW = VW / WW
      YPOR = YPHIJ / CM
      BB=WW*YZJ+YPHIJ*VOR
      PX = (PW - P(NA,M)) * DDX
      DWW = DW * WW
      ETA = WW ** 2 - ASQW
      CDUMP=(ETA*(1.+CPHOB**2)+(WW*CZM)**2)/ASQW
      IF (CDUMP .GE. 0.) GO TO 1001
      CALL DMPSQRT(5HWALL2,1,Z,K,M,NC,CDUMP)
 1001 BETA = -SQRT(CDUMP)
      ALAM = ASQW * (BETA - CZM) / ETA
      DUM4 = VW + CPHOB * UW
      AAX = -UNOR(NA,JSG) * DDX
      DSY=(SCY(JR)-SCY(JL))*DDY
      V2Y=(V2C(JR)-V2C(JL))*DDY
      IF (IJUMP1C(M) .EQ. 0) GO TO 20
      IF (IJUMP1C(M) .EQ. 2) GO TO 15
      IF (L .EQ. 1) GO TO 10
      IF (IJUMP1C(M) .NE. 3) GO TO 210
      IF (IJMPKTC(M) .GT. NJMPKT) GO TO 230
      IFAC = NJMPKT
      GO TO 215
  210 CONTINUE
      IF (IJMPKTC(M) .GT. NJMKTC) GO TO 230
      IFAC = NJMKTC
      IF (ICFL*KCFL .NE. 0) GO TO 215
      IJMPKTC(M) = IJMPKTC(M) + KFAC
      GO TO 10
  215 CONTINUE
      IJMPKTC(M) = IJMPKTC(M) + 1
      GO TO 10
  230 CONTINUE
      IJUMP1C(M) = 2
      IJMPKTC(M) = 0
      GO TO 15
   10 FAC=FLOAT(IJMPKTC(M)-1)/FLOAT(IFAC)
      PX = FAC * PX
      AAX = FAC * AAX
      WRITE (LLLLL,2002) Z, M, L, FAC
   15 CONTINUE
      MODIC = 0
      ISWMODC = 0
      ICONT(M)=ICONT(M)+1
      IF (ICONT(M) .EQ. 1) WRITE (LLLLL,2000) Z, MODIC, ISWMODC, M
   20 CONTINUE
      IF (ISWMODC .EQ. 3) GO TO 25
      DVOWY = (VOCY(JR) - VOCY(JL)) * DDY
      PY = (PCY(JR) - PCY(JL)) * DDY
      DUMM = (CZM / CM + YPOR * DVOWY) * WW
      DUM = BB * WW / ASQW - YZJ
      PZ23=(ALAM*DUM+CZM*YZJ+YPOR*CPHOB)*PY
     1    -DWW*(BB*(C5(JSG)+VOW*C3(JSG))
     2   -ALAM*(DUMM+(TF6(NC,JSG)-TG6(JSG))*WW+VOR*TF7(NC,JSG)))
      V2Z23 (BB*(V2Y-UW*C3(JSG))+YPOR*PY/DW)/WW
      GO TO 50
   25 TG5J=TG5(JSG)
      DO 40 I=1,4
      DCGY(I)=(CG(I,NC,JR)*DETY(NC,JR)-CG(I,NC,JL)*DETY(NC,JL))*DDY
   40 CONTINUE
      CE1=DW*(UW/CM+TG5J*BB+TF6(NC,JSG)*WW+TF7(NC,JSG)*VOR)
      DUM1 = (TG5J * YZJ + TG6(JSG)) * PW
      DUM2 = (TG5J * YPHIJ + CPHOB) * PW / CM
      QSQ=WW**2+VW**2+UW**2
      DUM3=UW*DCGY(3)-QSQ*DCGY(1)+WW*(DCGY(2)+DUM1)+VW*(DCGY(4)+DUM2)
C   ***   THE EQUATION FOR XK1 IS VALID FOR PERFECT GAS ONLY    ***
      XK1=-DW/(ASQW*GB)
```

SUBROUTINE WALL2

```
      PZ23=ALAM*WW*(CE1+2.*DCGY(1)+XK1*DUM3/DW)
     1    +(CZM-ALAM)*(DCGY(2)+DUM1)-DCGY(3)+CPHOB*(DCGY(4)+DUM2)
      V2Z23=(CPHOB*DCGY(3)-DUM4*DCGY(1)+DCGY(4)+DUM2)/DWW
   50 PZ=ALAM*XRW*PX-(DWW*(ALAM*AAX-WW*C7(JSG)
     1    -VW*C4(JSG)+DUM4*VOW/CM)+PZ23)/BETA
      V2Z=UW*C4(JSG)-VOR*CZM-V2Z23
      IF (MODIC .NE. 1) GO TO 90
      IF (L .EQ. 1) GO TO 80
      PXX = (-2.0 * P(NA,M) + P(NC2,M) + PW) * DDX
      AAXX = (-2.0 * UNOR(NA,JSG) + UNOR(NC2,JSG)) * DDX
      PZCORC(M)=ALAM*(XRW*PXX-DWW*AAXX/BETA)
      GO TO 90
   80 PZ=PZ+PZCORC(M)
   90 IF (M .GT. ISWSMOC) GO TO 100
      CALL RGAS(P(NC2,M),D(NC2,M),SW3,4)
      CALL RGAS(P(NA,M),D(NA,M),SW2,4)
      SZ=2.*SW2-SW3
      IF(SW2.LT.SW3)SZ=.5*(SW2+SW3)
      CUP(2,NC,M)=SZ*FLOAT(L)
      CU(2,NC,M)=SZ
      SZ=0.
      GO TO 125
  100 SZ=-BB*DSY/WW
  125 CONTINUE
      PZ=PZ/PW
      MODIC = KMODIC
      ISWMODC = KSWMOD
      IF(IJUMPC(M).EQ.0)GO TO 110
      IF(L.EQ.1)GO TO 110
      PZ=0.
      WRITE (LLLLL,2001) Z, M
  110 CONTINUE
      RETURN
C
 2000 FORMAT (5X, * FROM WALL2-- AT Z = *,F15.7,* MODIC AND ISWMODC ARE PE
     SRMANENTLY SET TO*,2I4,* ON PLANE *, I4)
 2001 FORMAT (5X, * FROM WALL2-- IN PREDICTOR STEP AT Z= *, F10.5,
     1    * PZ IS SET TO 0.0 ON PLANE*, I5)
 2002 FORMAT (5X, * FROM WALL2-- AT Z= *, F15.7, * AND ON PLANE*, I5,
     1    * L= *, I5, * X DERIVATIVES ARE SCALED BY *, F10.5)
      END
```

SUBROUTINE WALL2
(new)

APPENDIX C. USER INSTRUCTIONS FOR APPLICATION OF SWINT TO AN INLET CONFIGURATION

The first step in calculating an inlet configuration is to determine the flow field at the inlet face. This is accomplished by running SWINT to the inlet face and saving TAPE17 which contains the final flow field information. The procedure for doing this with the extended version of SWINT is identical to that for the original version and is described in Reference 2. The output differs from that of the original SWINT in two respects: (1) a PTO/PTINF column has been added to the flow field output which is the ratio of the local stagnation pressure to the freestream stagnation pressure; (2) The program stops exactly at z = ZEND rather that at the first step greater than ZEND.

Interface Program COWLI

The COWLI program rezones the flow field to lie between the inner body and the cowl. In addition, the inlet plane parameters described in Section 2.2 are calculated. This program is applicable even when the inlet or portions of it lie outside of the flow field generated by SWINT at the inlet face. At points outside of the SWINT generated flow field, freestream conditions are assumed to exist. It is also possible to use COWLI to generate a starting flow field for external calculations downstream of the inlet lip, even in cases where the bow shock lies completely within the inlet

To run the COWLI program the flow field at the inlet plane generated by SWINT must be attached as TAPE11 and relevant quantities in namelist INPUTS must be defined:

BNEW,BZNEW,BPHNEW - Inner wall boundary of the computational domain $b(\phi,z)$ and its derivatives $b_z(\phi,z)$ and $b_\phi(\phi,z)$. (See Figures 1,2)

CNEW,CZNEW,CPHNEW - Cowl or shock surface description $c(\phi,z)$ and its derivatives $c_z(\phi,z)$ and $c_\phi(\phi,z)$. (See Figures 1,2)

IBODY Controls conditions prescribed along inner boundary.

0 - inner body shape is not changed. BNEW,BZNEW,BPHNEW need not be specified.

1 - inner body shape is changed to BNEW,BZNEW,BPHNEW, which must be specified. Interpolated flow values at the wall are turned tangent to the surface using an oblique shock or Prantl-Meyer expansion.

2 - Same as IBODY = 1, except wall properties are also assigned between the body and shock. The outer boundary is assumed to be a shock with c_z calculated from the shock or Mach angle occuring at the wall, $c = b + (c_z - b_z)$, and $c_\phi = b_\phi$.

ICOWL Controls the conditions prescribed at the outer boundary and the type of surface (i.e., shock or cowl).

0 - outer surface geometry is not changed and CNEW,CZNEW,CPHNEW need not be specified.

1 - outer surface is a cowl with description CNEW,CZNEW,CPHNEW. Interpolated flow values at the cowl are turned parallel to the cowl surface.

2 - outer boundary is a Mach surface. The user specifies CNEW,CPHNEW and CZNEW is computed.

DDZ	Distance from the cowl lip at which calculation is started. Specified only when IBODY = 2.
RCLUST	Controls radial distribution of mesh points. Default is a uniform distribution. For other cases enter (r-b)/(c-b) for each radial plane starting at the body and moving towards the outer boundary. The same radial distribution is presumed on each constant φ plane.
AREA	Reference area used in calculating induced load coefficients. Default is the inner body cross-sectional area at the inlet entrance plane.
IPRINT	Controls the amount of printed output

0 - print only inlet plane flow field parameters.
(i.e., Eqs (4) and (5))

1 - (default) IPRINT = 0 output plus final rezoned flow field.

2 - IPRINT = 1 output plus initial flow field from Tape 11.

3 - IPRINT = 2 output plus Jump subroutine messages.

To apply the interface program to an inlet geometry, options IBODY=0/ICOWL=1 or IBODY=1/ICOWL=1 are used depending on whether the innerbody slope or surface is discontinuous at the inlet face plane. Three additional modes of operation are IBODY=2/ICOWL=0,IBODY=1/ICOWL=2, and IBODY=1/ICOWL=0. These options are designed to facilitate restart of an external calculation downstream of the inlet lip. The first,IBODY=2/ICOWL=0 is applicable when the bow shock lies completely inside the cowl. Slightly downstream of the inlet lip, the flow values obtained by turning the free-stream tangent to the COWL outer surface provides an estimate of the local flow field. An alternative approach for handling this situation which is also applicable when the bow shock is only partially within the inlet is accomplished with IBODY=1/ICOWL=2. Here the outer edge of the computational domain is defined to be a Mach surface. As the SWINT calculation proceeds downstream from the lip, the shock or Prandtl-Meyer expansion generated at the body surface by IBODY=1 propagates into the flow field and merges with the outer Mach surface. The final option, IBODY=1/ICOWL=0 duplicates the function of the INLET subroutine of SWINT.

The output from COWLI consists of Tape3 which is the restart file for SWINT and printed data. The amount of flow field information printed is controlled by the parameter IPRINT and the output flow field quantities are designated using the same headings as found in SWINT. The items printed under the heading "inlet plane flow field parameters" are described in Section 2.2. The induced force coefficients are followed by a value labeled force error. This number is the percent discrepency obtained by calculating the

forebody loads using direct pressure integration as opposed to Equations (5).

Applying SWINT to Inlets

The extended version of SWINT is applied to an inlet configuration in a manner similar to that described in Reference 2 for external configurations. Several additional variables must be prescribed along with a description of the geometry of the cowl.

The cowl geometry is described in a manner analogous to that used to describe the body. The quantities $c, c_z, c_\phi, c_{zz}, c_{z\phi}$, and $c_{\phi\phi}$ must be specified using fortran statements inserted at the indicated locations in subroutine COWL of SWINT. As an example, consider a circular cowl starting at $z = 1$ with a radius of 2 and an outwards angle of 7° relative to the missile axis for $z > 1$. The necessary statements describing the cowl are:

$$c_z = .12278456$$

$$c = 2. + (z-1)*c_z$$

$$c_{zz} = c_{z\phi} = c_{\phi\phi} = c_\phi = 0$$

The final statement is not required since default derivative values are 0.

The additional variables which control the computation of the cowl surface are specified in namelist INPUT1:

ICOWL	0 if the outer boundary is a shock and 1 if the outer boundary is a wall.

ICOWOPT — 0; cowl slope and surface is continuous at starting plane.
1; A cowl slope or surface discontinuity occurs at the starting plane. This results in the cowl surface normal derivatives being modified for 4 steps.

MOD1C — Controls order of accuracy of cowl boundary conditions.
0 - first order, 1 - second order.

ISWSMOC — Controls application of entropy extrapolation at cowl.
Extrapolation is applied on planes M<ISWSMOC

ISWMODC — Controls form of cowl boundary equations:
0 - Form 2A and 3A (Analogous to 14A and 15A of Ref. 2 for centerbody)

3 - Form 2C and 3C (Analogous to 14C and 15C of Ref. 2 for centerbody)

The variables MOD1C, ISWMODC and ISWSMOC are analogous to the body variables MOD1, ISWMOD and ISWSMO respectively. Recommended values for these parameters are discussed in Reference 2.

The output from a run for an inlet configuration differs from an external flow field calculation in the following respects:

1. At each plane where the flow field is printed, PTAVR/PTINF is calculated which is the area weighted average of the recovery pressure divided by the free-stream recovery pressure.

2. At the completion of the calculation, the cowl pressures are printed.

3. The force and moment coefficients represent the integration of pressure over both the centerbody and cowl surfaces, but do not include induced loads.

APPENDIX D. SAMPLE RUN

This appendix illustrates the application of the extended SWINT code to the inlet configuration shown in Figure D-1. The initial flow field was calculated at z = .1 using the approximate conical starting program START which is described in Reference 2. The data cards used for this run are:

```
$INPUTS
  NC = 19,
  MC = 13,
  ADM = 3.3,
  ATTACK = 3.0,
  B(1) = 0.017633,
  Z = 0.1,
  ZS = 0.1,
$END
```

This program generates TAPE3 which is the SWINT starting tape.

Using the extended version of SWINT with the errata update file, the flow field was marched from the starting plane at z=.1 to the start of the cowl which is located at z = 3.216. The errata update file is as follows:

```
*IDENT ERRATA
*DELETE EDGE.134,EDGE.135
      DUM = 0.0
      CALL JUMPF (I1, N, M, DUM)
      IF (MM .NE. M) CALL JUMPF (I2, N, MM, DUM)
*DELETE EDGE.78
     1   ABS (PHI(M) - PHI(MP)) * 0.35 / PINF)
*INSERT FRINGE.18
      B(M1) = B(M2)
      BZ(M1) = BZ(M2)
      BZZ(M1) = BZZ(M2)
      BZPHI(M1) = BZPHI(M2)
      BPHI(M1) = BPHI(M2)
      BPHPHI(M1) = BPHPHI(M2)
*DELETE REZONE.45,REZONE.46
*INSERT REZONE.40
      DX = 1.0 / FLOAT (NA)
      DDX = NA
*INSERT FIELD.31
      IF (IFIN .EQ. 0) GO TO 16
*INSERT FIELD.38
   16 CONTINUE
*DELETE INTEG.41,INTEG.43
      DTHETA = TH(I2,1) - TH(I,1)
      IF (M * (1 - IDYAW) .EQ. 2) DTHETA = 2.0 * TH(I,1)
      IF (M * (1 - IDYAW) .EQ. MP1) DTHETA = 2.0 * (PHIO - TH(I,1))
*DELETE TRANGD.27,TRANGD.30
    5 CONTINUE
      DY = 1.0 / FLOAT (NSGD)
      SGDM2 = SGD(NSGD) - 1.0
      SGD(1) = SGD(NSGDP1) - 1.0
      SGDP2 = 1.0 + SGD(3)
      SGD(NSGDP2) = 1.0 + SGD(2)
*DELETE SHOCK.68
      DCUZ(I) = (FAC1 * DDX + FAC2 * DDY + CES(I)) / PINF
*DELETE FRINGE.35
      PYY = (P(N,M) - P(N,MP)) / (PHI(M) - PHI(MP)) / PINF
*INSERT FRINGE.26
      R(N,M1) = R(N,M2)
```

```
*DELETE OUT.208,OUT.211
      CY=XK0*FY
      CMX=XK1*(MX + ZC*FY)
      CMY=XK1*(MY - ZC*FN)
      CMZ=XK1*MZ
*DELETE OUT.214,OUT.215
      IF(CN.NE.0) XCPP=ZC/ZREF + CMY/CN + Z0/ZREF
      IF(CY.NE.0) XCPY=ZC/ZREF - CMX/CY + Z0/ZREF
*DELETE FEVAL.41
      SF(6)=RF *(COSPP*SF(5)+SINPP*SF(1))
*DELETE REZONE.80
*DELETE REZONE.82
```

The configuration geometry was described using the following update deck:

center-body:

```
*IDENT PRESSLY
*B BODY.19
      REAL XHC(100),YHC(100),ZSAVE(3),BSAVE(3)
      DATA XHC/0.0, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.55, 4.6, 4.65,
     1 4.7, 4.8, 4.9, 5.1, 5.3, 5.5, 5.6, 5.7, 5.8, 5.9, 6./
      DATA YHC/0., .70532, .7228, .7387, .7512, .759, .7625,
     1 .763, .7625, .7611, .7585, .7504, .7391, .712, .6829, .6525,
     2 .6362, .618, .5973, .5744, .5467/
      DATA KK /0/
      NPTS=20
      KK=KK+1
      ZDIFF=.001
      IF(KK.GT.2)ZDIFF=DZ
      ZSAVE(1)=Z-ZDIFF
      ZSAVE(2)=Z
      ZSAVE(3)=Z+ZDIFF
      DO 30 J=1,3
         DO 20 I=1,NPTS
            IF((XHC(I)-ZSAVE(J))*(XHC(I+1)-ZSAVE(J)).GT.0.)GO TO 20
            FAC=(ZSAVE(J)-XHC(I))/(XHC(I+1)-XHC(I))
            BSAVE(J)=YHC(I)+(YHC(I+1)-YHC(I))*FAC
            GO TO 30
   20    CONTINUE
         WRITE(6,2000)Z,ZDIFF,ZSAVE
 2000    FORMAT(*1GEOMETRY OUT OF RANGE Z,ZDIFF,ZSAVE *,5E16.8)
         STOP"BAD GEOMETRY"
   30 CONTINUE
      BBZ=(BSAVE(3)-BSAVE(1))/(2.*ZDIFF)
      BBZZ=(BSAVE(3)-2.*BSAVE(2)+BSAVE(1))/(ZDIFF*ZDIFF)
*I BODY.35
      IF(Z.LE.4.)GO TO 18
      B(M)=BSAVE(2)
      BZ(M)=BBZ
      BZZ(M)=BBZZ
      GO TO 19
   18 CONTINUE
      BZ(M)=.17633
      B(M)=Z*BZ(M)
   19 CONTINUE
```

cowl:

```
*B COWLADD.56
      REAL XHC(100),YHC(100),ZSAVE(3),CSAVE(3)
      DATA XHC/2.858, 3.1, 3.2, 3.4, 3.6, 3.8, 4.0, 4.1, 4.2, 4.25,
     1   4.3, 4.4, 4.5, 4.55, 4.6, 4.65, 4.7, 4.8, 4.9, 5., 5.1, 5.6,
     2   5.8, 5.9, 6.0/
      DATA YHC/1., 1.004188, 1.0054, 1.0051, .99996, .9882, .9681,
     1   .954, .9364, .9261, .9154, .8949, .8768, .8695, .864,
     2   .86, .8572, .8533, .8511, .8502, .85, .85, .8574,
     3   .8646, .8735/
      DATA KK/0/
      NPTS  =24
      KK=KK+1
      ZDIFF=.001
      IF(KK.GT.2)ZDIFF=DZ
      ZZ=Z-.356
      ZSAVE(1)=ZZ-ZDIFF
      ZSAVE(2)=ZZ
      ZSAVE(3)=ZZ+ZDIFF
```

```
      DO 30 J=1,3
         DO 20 I=1,NPTS
            IF((XHC(I)-ZSAVE(J))*(XHC(I+1)-ZSAVE(J)).GT.0.)GO TO 20
            FAC=(ZSAVE(J)-XHC(I))/(XHC(I+1)-XHC(I))
            CSAVE(J)=YHC(I)+(YHC(I+1)-YHC(I))*FAC
            GO TO 30
   20    CONTINUE
         WRITE(6,2000)Z,ZDIFF,ZSAVE
 2000    FORMAT(*1GEOMETRY OUT OF RANGE Z,ZDIFF,ZSAVE *,5E16.8)
         STOP*BAD COWL GEOMETRY*
   30 CONTINUE
      CCZ=(CSAVE(3)-CSAVE(1))/(2.*ZDIFF)
      CCZZ=(CSAVE(3)-2.*CSAVE(2)+CSAVE(1))/(ZDIFF*ZDIFF)
*I COWLADD.73
      C(M)=CSAVE(2)
      CZ(M)=CCZ
      CZZ(M)=CCZZ
```

The cards designated as COWLADD.73 and COWLADD.56 are so marked in Appendix B.

The namelist inputs used to make this run were:

```
$INPUT1
KA=2000,ZEND=3.216,
ISWMODC=0,MOD1C=0,ISWMOD=0,MOD1=0,
$END
$OUTRD
KOUT(1)=40,
$END
```

Sample output sheets from this run are shown in Table D-1. The restart file from this run is written to TAPE17.

To complete the calculation of the inlet configuration, program COWLI is used to rezone the flow field so that it lies within the inlet. To run COWLI, the restart tape generated by SWINT at z = 3.216 is accessed as TAPE11 and namelist quantities must be defined. The data cards used for this run are:

```
$INPUTS
ICOWL=1,CNEW=1.,CZNEW=.0174,CPHNEW=0.,
IPRINT=0,
$END
```

The output from COWLI is shown in Table D-2. The rezoned restart file generated by COWLI is TAPE3.

The inlet section of the configuration is run using the restart file generated by COWLI which is accessed as TAPE3. The data cards used to complete this run are:

```
$INPUT1
ICOWL=1,ICOWOPT=1,
KA=2000,ZEND=5.2,
ISWMODC=0,MOD1C=0,ISWMOD=0,MOD1=0,
$END
$OUTRD
KOUT(1)=40,
$END
```

The output from this run is shown in Table D-3.

Table D-1. SWINT Forebody run (z = .1 to 3.216)

```
******* PROGRAM SWINT  DATE   83/10/25.      TIME   08.52.05.  *******

****FREE STREAM CONDITIONS****

     MACH NUMBER          3.3000E+00
     ANGLE OF ATTACK      3.0000E+00
     ANGLE OF YAW         0.
     VINF                 1.2347E+03
     PINF                 1.0000E+00
     DINF                 1.0000E-05
     HINF                 3.5000E+05
     H0                   1.1123E+06
     SINF                 0.

**** PROBLEM SET UP****

     NC =              19        (NUMBER OF R-PLANES)
     MC =              13        (NUMBER OF PHI-PLANES)
     KA =            2000        (MAXIMUM NUMBER OF STEPS)
     ZEND =        3.2160        (MAXIMUM Z VALUE)
     FACTOR =       .9000        (CFL SAFETY FACTOR)
     PHIO =      180.0000        (MAXIMUM PHI)
     IDYAW =            0        (0-SYMMETRIC, 1-ASYMMETRIC)
     IZONE =            0        (IF IZONE .GT. 0 THEN REZONE)
     ICOWL =            0        (OUTER BOUNDARY DEFINITION. 1=WALL,0=SHOCK)
     NSFD =             0        (IF NSFD .GT. 0 USER READS IN A MESH CLUSTERED IN R - DIRECTION)
     NSGD =             0        (IF NSGD .GT. 0 USER READS IN A MESH CLUSTERED IN PHI - DIRECTION)
     JM1 =              1        (=0 DIFFERENCE USING M,M-1 , =1 USE M+1,M - FOR PREDICTOR)
     JM2 =              0        (=0 DIFFERENCE USING M,M-1 , =1 USE M+1,M - FOR CORRECTOR)
     JN1 =              1        (=0 DIFFERENCE USING N,N-1 , =1 USE N+1,N - FOR PREDICTOR)
     JN2 =              0        (=0 DIFFERENCE USING N,N-1 , =1 USE N+1,N - FOR CORRECTOR)
     ISWDIF =           0        (=1 ALLOWS DIFFERENCING OPTION TO BE SWITCHED IN SUCCESSIVE STEPS, =0 NO SWITCHING)
     ZCFL1 =       6.4320        (LOWER BOUNDARY OF INTERVAL IN WHICH CFL FACTOR IS REDUCED)
     ZCFL2 =       6.4320        (UPPER BOUNDARY OF INTERVAL IN WHICH CFL FACTOR IS REDUCED)
     KFAC =             3        (IN INTERVAL ZCFL1 TO ZCFL2, CFL FACTOR REDUCED BY KFAC)

**** OUTPUT CONTROL****

     KOUT =      40     20     20     20     20            (PRINT FREQUENCY)
     ZPRINT =   10000.00   10000.00   10000.00   10000.00   10000.00 (TRANSITION PT IN Z FOR KOUT)
     ZTARGET =     0.00    0.00    0.00    0.00    0.00     (TARGET OUTPUT STATIONS)
     NMAX =         19                                      (OUTPUT RESTICTED FOR N .LE. NMAX)
     MMIN, MMAX =          2        14                      (OUTPUT RESTRICTED FOR MMIN .LE. M .LE. MMAX)
     ZTAPE = 10000.0000                                     (PLOT TAPE WRITTEN AT EACH OUTPUT Z .GT. ZTAPE)
     DZPRINT = 10000.0000                                   (Z INTERVAL FOR FIELD OUTPUT)
     JJJJJ =            9                                   (=6 PRINT DEBUG WRITE MESSAGES, =9 NO PRINTING)
     LLLLL =            9                                   (=6 PRINT DEBUG WRITE MESSAGES, =9 NO PRINTING)
     IPCID =            0                                   (=0 PINF/P PRINTED IN OUT, =1 CP PRINTED)
     INTRE =            0                                   (NUMBER OF CONSTANT RADIAL LINES FOR FIN SURFACE PRESSURE INTERPOLATION)
     RINT =      -R    -R    -R    -R    -R    -R    -R    -R    -R  (INTERPOLATION RADII)

**** WALL OPTIONS****

     ISWSMO =       0          (ISWSMO = 1 -ENTROPY EXTRAPOLATION, =0 -STANDARD)
     ISWMOD =       0          (FORM OF BOUNDARY CONDITIONS- 0 = 14A,15A,  3 = 14C,15C)
```

Table D-1 (Continued)

```
MODI =          0          (ORDER OF ACCURACY -- 0=1ST ORDER, 1=2ND ORDER UNTIL BODY DISCONTINUITY ENCOUNTERED)
ISEP =          0          (0 = ON SEPARATION, 1 = SEPARATION AND INTERIOR POINT SMOOTHING)
ZJLOW =      0.00          (LOWER BOUNDARY OF INTERVAL IN WHICH A BODY JUMP IS IGNORED)
ZJHI =       0.00          (UPPER BOUNDARY OF INTERVAL IN WHICH A BODY JUMP IS IGNORED)
KCFL =          0          (NUMBER OF STEPS AFTER AN EXPANSION DISCONTINUITY TO REDUCE CFL FACTOR)
NJMPKT =        0          (MAX NUMBER OF STEPS AFTER AN EXPANSION DISCONTINUITY FOR WHICH X-DERIVATIVES AT WALL SET =0)
NJMKTS =        4          (MAX NUMBER OF STEPS AFTER A COMPRESSION DISCONTINUITY FOR WHICH X-DERIVATIVES AT WALL SET =0)


**** FIN OPTIONS****

IFIN =       0          (NUMBER OF FINS)
NFIN =       0          (NUMBER OF FIN SURFACES)


**** SMOOTHING OPTIONS****

ZSMON =        0.00       (IF Z .GT. ZSMON, SMOOTHING IS TURNED ON)
ZSMOFF =   10000.00       (IF Z .GT. ZSMOFF, SMOOTHING IS TURNED OFF)

** INTERIOR POINTS**

IFD =          0          (0 = NO SMOOTHING, 1 = SMOOTH)
THCX =    0.0000          (SMOOTHING COEFFICIENT IN X DIRECTION)
THCY =    0.0000          (SMOOTHING COEFFICIENT IN Y DIRECTION)

** SURFACE POINTS**

NSMTH =       0                          (NUMBER OF SMOOTHING REGIONS)
N9 =      0     0     0     0     0     0     0     0     0   (OUTER N-LIMIT FOR SMOOTHING)
M8 =      0     0     0     0          (LOWER M-LIMIT FOR SMOOTHING)
M9 =      0     0     0     0          (UPPER M-LIMIT FOR SMOOTHING)
X9 =   0.00  0.00  0.00  0.00          (.GT. 0 SMOOTHING CONSTANT, .LT. 0 ABS MULTIPLIED BY DENSITY SWITCH)

MACH NO IS  3.3000000E+00     ANGLE OF ATTACK IS  3.0000000E+00     ANGLE OF SIDESLIP IS  0.

PLANE   2   ANGLE IS   0.00 DEGREES

STATION    0    Z IS  1.0000000E-01    C IS  3.5063389E-02    CZ IS  3.5063389E-01    CPHI IS  0.
B IS  1.763300E-02  BZ IS  1.763300E-01  BPHI IS  0.          BZZ IS  0.           BZPHI IS  0.          BPHPHI IS  0.
```

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	3.5063E-02	1.1861E+03	6.9425E+01	0.	1.6662E+00	9.8660E-01	1.4345E-05	1.6123E+01	2.9463E+00	-R	-R	****
18	3.4095E-02	1.1833E+03	7.7469E+01	0.	1.7053E+00	9.8660E-01	1.4584E-05	1.6123E+01	2.9309E+00	-R	-R	****
17	3.3127E-02	1.1808E+03	8.4789E+01	0.	1.7392E+00	9.8660E-01	1.4791E-05	1.6123E+01	2.9179E+00	-R	-R	****
16	3.2158E-02	1.1786E+03	9.1680E+01	0.	1.7695E+00	9.8660E-01	1.4975E-05	1.6123E+01	2.9064E+00	-R	-R	****
15	3.1190E-02	1.1765E+03	9.8311E+01	0.	1.7971E+00	9.8660E-01	1.5141E-05	1.6123E+01	2.8962E+00	-R	-R	****
14	3.0222E-02	1.1745E+03	1.0480E+02	0.	1.8225E+00	9.8660E-01	1.5294E-05	1.6123E+01	2.8869E+00	-R	-R	****
13	2.9253E-02	1.1726E+03	1.1121E+02	0.	1.8461E+00	9.8660E-01	1.5435E-05	1.6123E+01	2.8784E+00	-R	-R	****
12	2.8285E-02	1.1708E+03	1.1763E+02	0.	1.8681E+00	9.8660E-01	1.5566E-05	1.6123E+01	2.8707E+00	-R	-R	****
11	2.7317E-02	1.1690E+03	1.2411E+02	0.	1.8885E+00	9.8660E-01	1.5688E-05	1.6123E+01	2.8635E+00	-R	-R	****
10	2.6348E-02	1.1672E+03	1.3068E+02	0.	1.9076E+00	9.8660E-01	1.5800E-05	1.6123E+01	2.8569E+00	-R	-R	****
9	2.5380E-02	1.1655E+03	1.3741E+02	0.	1.9252E+00	9.8660E-01	1.5905E-05	1.6123E+01	2.8508E+00	-R	-R	****
8	2.4411E-02	1.1638E+03	1.4433E+02	0.	1.9414E+00	9.8660E-01	1.6000E-05	1.6123E+01	2.8453E+00	-R	-R	****
7	2.3443E-02	1.1621E+03	1.5150E+02	0.	1.9562E+00	9.8660E-01	1.6087E-05	1.6123E+01	2.8403E+00	-R	-R	****
6	2.2475E-02	1.1604E+03	1.5896E+02	0.	1.9694E+00	9.8660E-01	1.6165E-05	1.6123E+01	2.8359E+00	-R	-R	****
5	2.1506E-02	1.1587E+03	1.6678E+02	0.	1.9809E+00	9.8660E-01	1.6232E-05	1.6123E+01	2.8321E+00	-R	-R	****
4	2.0538E-02	1.1570E+03	1.7501E+02	0.	1.9905E+00	9.8660E-01	1.6288E-05	1.6123E+01	2.8289E+00	-R	-R	****
3	1.9570E-02	1.1552E+03	1.8374E+02	0.	1.9978E+00	9.8660E-01	1.6331E-05	1.6123E+01	2.8265E+00	-R	-R	****
2	1.8601E-02	1.1534E+03	1.9306E+02	0.	2.0026E+00	9.8660E-01	1.6359E-05	1.6123E+01	2.8249E+00	-R	-R	****
1	1.7633E-02	1.1516E+03	2.0306E+02	0.	2.0044E+00	9.8660E-01	1.6369E-05	1.6123E+01	2.8243E+00	-R	-R	****

Table D-1. (Continued)

PLANE 3 ANGLE IS 15.00 DEGREES

STATION 0 Z IS 1.0000000E-01 C IS 3.5112223E-02 CZ IS 3.5112223E-01 CPHI IS 0.
B IS 1.763300E-02 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	3.5112E-02	1.1867E+03	6.9570E+01	1.6725E+01	1.6538E+00	9.8717E-01	1.4271E-05	1.6123E+01	2.9516E+00	-R	-R	****
18	3.4141E-02	1.1839E+03	7.7621E+01	1.6725E+01	1.6928E+00	9.8717E-01	1.4511E-05	1.6123E+01	2.9361E+00	-R	-R	****
17	3.3170E-02	1.1815E+03	8.4930E+01	1.6725E+01	1.7266E+00	9.8717E-01	1.4717E-05	1.6123E+01	2.9230E+00	-R	-R	****
16	3.2199E-02	1.1792E+03	9.1819E+01	1.6725E+01	1.7568E+00	9.8717E-01	1.4901E-05	1.6123E+01	2.9116E+00	-R	-R	****
15	3.1228E-02	1.1771E+03	9.8438E+01	1.6725E+01	1.7843E+00	9.8717E-01	1.5067E-05	1.6123E+01	2.9013E+00	-R	-R	****
14	3.0257E-02	1.1752E+03	1.0491E+02	1.6725E+01	1.8096E+00	9.8717E-01	1.5219E-05	1.6123E+01	2.8920E+00	-R	-R	****
13	2.9286E-02	1.1733E+03	1.1132E+02	1.6725E+01	1.8331E+00	9.8717E-01	1.5360E-05	1.6123E+01	2.8835E+00	-R	-R	****
12	2.8315E-02	1.1714E+03	1.1772E+02	1.6725E+01	1.8549E+00	9.8717E-01	1.5490E-05	1.6123E+01	2.8757E+00	-R	-R	****
11	2.7344E-02	1.1696E+03	1.2419E+02	1.6725E+01	1.8753E+00	9.8717E-01	1.5611E-05	1.6123E+01	2.8685E+00	-R	-R	****
10	2.6373E-02	1.1679E+03	1.3075E+02	1.6725E+01	1.8942E+00	9.8717E-01	1.5724E-05	1.6123E+01	2.8619E+00	-R	-R	****
9	2.5402E-02	1.1662E+03	1.3747E+02	1.6725E+01	1.9118E+00	9.8717E-01	1.5828E-05	1.6123E+01	2.8558E+00	-R	-R	****
8	2.4430E-02	1.1644E+03	1.4438E+02	1.6725E+01	1.9280E+00	9.8717E-01	1.5924E-05	1.6123E+01	2.8502E+00	-R	-R	****
7	2.3459E-02	1.1627E+03	1.5155E+02	1.6725E+01	1.9427E+00	9.8717E-01	1.6010E-05	1.6123E+01	2.8452E+00	-R	-R	****
6	2.2488E-02	1.1610E+03	1.5901E+02	1.6725E+01	1.9559E+00	9.8717E-01	1.6088E-05	1.6123E+01	2.8408E+00	-R	-R	****
5	2.1517E-02	1.1593E+03	1.6682E+02	1.6725E+01	1.9673E+00	9.8717E-01	1.6155E-05	1.6123E+01	2.8370E+00	-R	-R	****
4	2.0546E-02	1.1576E+03	1.7507E+02	1.6725E+01	1.9769E+00	9.8717E-01	1.6211E-05	1.6123E+01	2.8338E+00	-R	-R	****
3	1.9575E-02	1.1559E+03	1.8381E+02	1.6725E+01	1.9842E+00	9.8717E-01	1.6254E-05	1.6123E+01	2.8313E+00	-R	-R	****
2	1.8604E-02	1.1541E+03	1.9314E+02	1.6725E+01	1.9890E+00	9.8717E-01	1.6282E-05	1.6123E+01	2.8298E+00	-R	-R	****
1	1.7633E-02	1.1523E+03	2.0318E+02	1.6725E+01	1.9908E+00	9.8717E-01	1.6292E-05	1.6123E+01	2.8292E+00	-R	-R	****

PLANE 13 ANGLE IS 165.00 DEGREES

STATION 0 Z IS 1.0000000E-01 C IS 3.9479962E-02 CZ IS 3.9479962E-01 CPHI IS 0.
B IS 1.763300E-02 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	3.9480E-02	1.2208E+03	9.3483E+01	1.6725E+01	1.1318E+00	9.9981E-01	1.0924E-05	1.6118E+01	3.2151E+00	-R	-R	****
18	3.8266E-02	1.2179E+03	1.0096E+02	1.6725E+01	1.1629E+00	9.9981E-01	1.1137E-05	1.6118E+01	3.1967E+00	-R	-R	****
17	3.7053E-02	1.2157E+03	1.0668E+02	1.6725E+01	1.1855E+00	9.9981E-01	1.1292E-05	1.6118E+01	3.1835E+00	-R	-R	****
16	3.5839E-02	1.2139E+03	1.1170E+02	1.6725E+01	1.2044E+00	9.9981E-01	1.1420E-05	1.6118E+01	3.1728E+00	-R	-R	****
15	3.4625E-02	1.2123E+03	1.1641E+02	1.6725E+01	1.2212E+00	9.9981E-01	1.1534E-05	1.6118E+01	3.1634E+00	-R	-R	****
14	3.3411E-02	1.2107E+03	1.2097E+02	1.6725E+01	1.2366E+00	9.9981E-01	1.1637E-05	1.6118E+01	3.1550E+00	-R	-R	****
13	3.2198E-02	1.2093E+03	1.2551E+02	1.6725E+01	1.2509E+00	9.9981E-01	1.1733E-05	1.6118E+01	3.1472E+00	-R	-R	****
12	3.0984E-02	1.2078E+03	1.3011E+02	1.6725E+01	1.2645E+00	9.9981E-01	1.1624E-05	1.6118E+01	3.1399E+00	-R	-R	****
11	2.9770E-02	1.2064E+03	1.3484E+02	1.6725E+01	1.2774E+00	9.9981E-01	1.1910E-05	1.6118E+01	3.1330E+00	-R	-R	****
10	2.8556E-02	1.2050E+03	1.3977E+02	1.6725E+01	1.2898E+00	9.9981E-01	1.1993E-05	1.6118E+01	3.1265E+00	-R	-R	****
9	2.7343E-02	1.2035E+03	1.4497E+02	1.6725E+01	1.3017E+00	9.9981E-01	1.2072E-05	1.6118E+01	3.1203E+00	-R	-R	****
8	2.6129E-02	1.2021E+03	1.5050E+02	1.6725E+01	1.3132E+00	9.9981E-01	1.2148E-05	1.6118E+01	3.1144E+00	-R	-R	****
7	2.4915E-02	1.2006E+03	1.5647E+02	1.6725E+01	1.3241E+00	9.9981E-01	1.2219E-05	1.6118E+01	3.1088E+00	-R	-R	****
6	2.3702E-02	1.1990E+03	1.6297E+02	1.6725E+01	1.3343E+00	9.9981E-01	1.2287E-05	1.6118E+01	3.1036E+00	-R	-R	****
5	2.2488E-02	1.1974E+03	1.7013E+02	1.6725E+01	1.3438E+00	9.9981E-01	1.2350E-05	1.6118E+01	3.0988E+00	-R	-R	****
4	2.1274E-02	1.1956E+03	1.7812E+02	1.6725E+01	1.3523E+00	9.9981E-01	1.2405E-05	1.6118E+01	3.0946E+00	-R	-R	****
3	2.0060E-02	1.1938E+03	1.8717E+02	1.6725E+01	1.3594E+00	9.9981E-01	1.2452E-05	1.6118E+01	3.0911E+00	-R	-R	****
2	1.8847E-02	1.1917E+03	1.9757E+02	1.6725E+01	1.3645E+00	9.9981E-01	1.2485E-05	1.6118E+01	3.0886E+00	-R	-R	****
1	1.7633E-02	1.1895E+03	2.0975E+02	1.6725E+01	1.3665E+00	9.9981E-01	1.2498E-05	1.6118E+01	3.0875E+00	-R	-R	****

PLANE 14 ANGLE IS 180.00 DEGREES

STATION 0 Z IS 1.0000000E-01 C IS 3.9596531E-02 CZ IS 3.9596531E-01 CPHI IS 0.
B IS 1.763300E-02 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	3.9597E-02	1.2213E+03	9.4394E+01	-2.2167E-13	1.1261E+00	9.9983E-01	1.0885E-05	1.6118E+01	3.2185E+00	-R	-R	****
18	3.8376E-02	1.2184E+03	1.0182E+02	-2.2167E-13	1.1569E+00	9.9983E-01	1.1097E-05	1.6118E+01	3.2002E+00	-R	-R	****

Table D-1. (Continued)

17	3.7156E-02	1.2162E+03	1.0746E+02	-2.2167E-13	1.1792E+00	9.9983E-01	1.1249E-05	1.6118E+01	3.1872E+00	-R	-R	****
16	3.5936E-02	1.2144E+03	1.1242E+02	-2.2167E-13	1.1978E+00	9.9983E-01	1.1376E-05	1.6118E+01	3.1766E+00	-R	-R	****
15	3.4716E-02	1.2128E+03	1.1705E+02	-2.2167E-13	1.2143E+00	9.9983E-01	1.1487E-05	1.6118E+01	3.1673E+00	-R	-R	****
14	3.3496E-02	1.2113E+03	1.2155E+02	-2.2167E-13	1.2294E+00	9.9983E-01	1.1589E-05	1.6118E+01	3.1589E+00	-R	-R	****
13	3.2275E-02	1.2098E+03	1.2603E+02	-2.2167E-13	1.2435E+00	9.9983E-01	1.1684E-05	1.6118E+01	3.1512E+00	-R	-R	****
12	3.1055E-02	1.2084E+03	1.3057E+02	-2.2167E-13	1.2569E+00	9.9983E-01	1.1774E-05	1.6118E+01	3.1439E+00	-R	-R	****
11	2.9835E-02	1.2070E+03	1.3524E+02	-2.2167E-13	1.2697E+00	9.9983E-01	1.1859E-05	1.6118E+01	3.1371E+00	-R	-R	****
10	2.8615E-02	1.2056E+03	1.4012E+02	-2.2167E-13	1.2819E+00	9.9983E-01	1.1940E-05	1.6118E+01	3.1306E+00	-R	-R	****
9	2.7395E-02	1.2042E+03	1.4526E+02	-2.2167E-13	1.2937E+00	9.9983E-01	1.2019E-05	1.6118E+01	3.1245E+00	-R	-R	****
8	2.6174E-02	1.2027E+03	1.5074E+02	-2.2167E-13	1.3050E+00	9.9983E-01	1.2093E-05	1.6118E+01	3.1186E+00	-R	-R	****
7	2.4954E-02	1.2012E+03	1.5666E+02	-2.2167E-13	1.3158E+00	9.9983E-01	1.2165E-05	1.6118E+01	3.1130E+00	-R	-R	****
6	2.3734E-02	1.1997E+03	1.6311E+02	-2.2167E-13	1.3259E+00	9.9983E-01	1.2232E-05	1.6118E+01	3.1078E+00	-R	-R	****
5	2.2514E-02	1.1980E+03	1.7023E+02	-2.2167E-13	1.3354E+00	9.9983E-01	1.2294E-05	1.6118E+01	3.1031E+00	-R	-R	****
4	2.1294E-02	1.1963E+03	1.7820E+02	-2.2167E-13	1.3438E+00	9.9983E-01	1.2350E-05	1.6118E+01	3.0988E+00	-R	-R	****
3	2.0073E-02	1.1944E+03	1.8723E+02	-[illegible]167E-13	1.3509E+00	9.9983E-01	1.2396E-05	1.6118E+01	3.0953E+00	-R	-R	****
2	1.8853E-02	1.1924E+03	1.9764E+02	-[illegible]2167E-13	1.3560E+00	9.9983E-01	1.2429E-05	1.6118E+01	3.0928E+00	-R	-R	****
1	1.7633E-02	1.1902E+03	2.0987E+02	-2.2167E-13	1.3580E+00	9.9983E-01	1.2443E-05	1.6118E+01	3.0917E+00	-R	-R	****

STEP= 1 DZ= 1.3435241E-03 CFL= 3.7215559E+01 N,M,J= 19 2 3 Z= 1.0134352E-01 OPTIONS= 0 0 0 JS= 1 1 0 0

STEP= 2 DZ= 1.3616197E-03 CFL= 3.6720973E+01 N,M,J= 19 2 3 Z= 1.0270514E-01 OPTIONS= 0 0 0 JS= 1 1 0 0

STEP= 3 DZ= 1.3799518E-03 CFL= 3.6233150E+01 N,M,J= 19 2 3 Z= 1.0408510E-01 OPTIONS= 0 0 0 JS= 1 1 0 0

STEP= 4 DZ= 1.3985237E-03 CFL= 3.5751986E+01 N,M,J= 19 2 3 Z= 1.0548362E-01 OPTIONS= 0 0 0 JS= 1 1 0 0

STEP= 5 DZ= 1.4173382E-03 CFL= 3.5277396E+01 N,M,J= 19 2 3 Z= 1.0690096E-01 OPTIONS= 0 0 0 JS= 1 1 0 0

MACH NO IS 3.3000000E+00 ANGLE OF ATTACK IS 3.0000000E+00 ANGLE OF SIDESLIP IS 0.

PLANE 2 ANGLE IS 0.00 DEGREES

STATION 272 Z IS 3.2160000E+00 C IS 1.0894893E+00 CZ IS 3.3849630E-01 CPHI IS 0.
B IS 5.670773E-01 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	1.0895E+00	1.1930E+03	5.3714E+01	0.	1.5704E+00	9.9071E-01	1.3767E-05	1.6122E+01	2.9884E+00	-R	-R	****
18	1.0605E+00	1.1903E+03	6.1638E+01	0.	1.6079E+00	9.9068E-01	1.4001E-05	1.6122E+01	2.9727E+00	-R	-R	****
17	1.0314E+00	1.1880E+03	6.8877E+01	0.	1.6407E+00	9.9066E-01	1.4204E-05	1.6122E+01	2.9592E+00	-R	-R	****
16	1.0024E+00	1.1858E+03	7.5749E+01	0.	1.6704E+00	9.9063E-01	1.4388E-05	1.6122E+01	2.9473E+00	-R	-R	****
15	9.7340E-01	1.1838E+03	8.2432E+01	0.	1.6980E+00	9.9059E-01	1.4557E-05	1.6122E+01	2.9364E+00	-R	-R	****
14	9.4437E-01	1.1818E+03	8.9044E+01	0.	1.7238E+00	9.9056E-01	1.4714E-05	1.6122E+01	2.9264E+00	-R	-R	****
13	9.1535E-01	1.1799E+03	9.5672E+01	0.	1.7482E+00	9.9051E-01	1.4863E-05	1.6122E+01	2.9171E+00	-R	-R	****
12	8.8633E-01	1.1780E+03	1.0239E+02	0.	1.7714E+00	9.9047E-01	1.5003E-05	1.6122E+01	2.9083E+00	-R	-R	****
11	8.5731E-01	1.1761E+03	1.0926E+02	0.	1.7934E+00	9.9042E-01	1.5136E-05	1.6122E+01	2.9001E+00	-R	-R	****
10	8.2828E-01	1.1742E+03	1.1636E+02	0.	1.8144E+00	9.9036E-01	1.5262E-05	1.6122E+01	2.8924E+00	-R	-R	****
9	7.9926E-01	1.1724E+03	1.2373E+02	0.	1.8344E+00	9.9029E-01	1.5381E-05	1.6122E+01	2.8851E+00	-R	-R	****
8	7.7024E-01	1.1705E+03	1.3145E+02	0.	1.8532E+00	9.9021E-01	1.5494E-05	1.6122E+01	2.8783E+00	-R	-R	****
7	7.4121E-01	1.1686E+03	1.3959E+02	0.	1.8708E+00	9.9011E-01	1.5598E-05	1.6122E+01	2.8720E+00	-R	-R	****
6	7.1219E-01	1.1666E+03	1.4825E+02	0.	1.8870E+00	9.9002E-01	1.5694E-05	1.6122E+01	2.8663E+00	-R	-R	****
5	6.8317E-01	1.1646E+03	1.5752E+02	0.	1.9015E+00	9.8981E-01	1.5779E-05	1.6122E+01	2.8611E+00	-R	-R	****
4	6.5415E-01	1.1625E+03	1.6749E+02	0.	1.9142E+00	9.8979E-01	1.5854E-05	1.6122E+01	2.8567E+00	-R	-R	****
3	6.2512E-01	1.1603E+03	1.7847E+02	0.	1.9234E+00	9.8912E-01	1.5906E-05	1.6122E+01	2.8531E+00	-R	-R	****
2	5.9610E-01	1.1580E+03	1.9000E+02	0.	1.9329E+00	9.8964E-01	1.5964E-05	1.6122E+01	2.8502E+00	-R	-R	****
1	5.6708E-01	1.1555E+03	2.0374E+02	0.	1.9305E+00	9.8660E-01	1.5936E-05	1.6123E+01	2.8490E+00	-R	-R	****

Table D-1. (Continued)

PLANE 3 ANGLE IS 15.00 DEGREES

STATION 272 Z IS 3.2160000E+00 C IS 1.0923011E+00 CZ IS 3.3936430E-01 CPHI IS 2.0766518E-02
B IS 5.670773E-01 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	1.0923E+00	1.1933E+03	5.4592E+01	1.4501E+01	1.5631E+00	9.9099E-01	1.3722E-05	1.6122E+01	2.9917E+00	-R	-R	****
18	1.0631E+00	1.1907E+03	6.2493E+01	1.4545E+01	1.6003E+00	9.9097E-01	1.3955E-05	1.6122E+01	2.9760E+00	-R	-R	****
17	1.0339E+00	1.1883E+03	6.9700E+01	1.4618E+01	1.6329E+00	9.9094E-01	1.4157E-05	1.6122E+01	2.9626E+00	-R	-R	****
16	1.0048E+00	1.1862E+03	7.6539E+01	1.4717E+01	1.6624E+00	9.9091E-01	1.4339E-05	1.6122E+01	2.9507E+00	-R	-R	****
15	9.7558E-01	1.1841E+03	8.3185E+01	1.4840E+01	1.6897E+00	9.9087E-01	1.4507E-05	1.6122E+01	2.9398E+00	-R	-R	****
14	9.4641E-01	1.1822E+03	8.9759E+01	1.4988E+01	1.7152E+00	9.9083E-01	1.4663E-05	1.6122E+01	2.9299E+00	-R	-R	****
13	9.1723E-01	1.1802E+03	9.6349E+01	1.5162E+01	1.7393E+00	9.9079E-01	1.4810E-05	1.6122E+01	2.9206E+00	-R	-R	****
12	8.8805E-01	1.1784E+03	1.0303E+02	1.5363E+01	1.7622E+00	9.9074E-01	1.4949E-05	1.6122E+01	2.9119E+00	-R	-R	****
11	8.5887E-01	1.1765E+03	1.0986E+02	1.5593E+01	1.7840E+00	9.9069E-01	1.5080E-05	1.6122E+01	2.9037E+00	-R	-R	****
10	8.2969E-01	1.1747E+03	1.1691E+02	1.5857E+01	1.8048E+00	9.9062E-01	1.5205E-05	1.6122E+01	2.8961E+00	-R	-R	****
9	8.0051E-01	1.1728E+03	1.2424E+02	1.6156E+01	1.8244E+00	9.9055E-01	1.5323E-05	1.6122E+01	2.8889E+00	-R	-R	****
8	7.7133E-01	1.1709E+03	1.3191E+02	1.6497E+01	1.8430E+00	9.9046E-01	1.5434E-05	1.6122E+01	2.8821E+00	-R	-R	****
7	7.4215E-01	1.1690E+03	1.4001E+02	1.6884E+01	1.8603E+00	9.9036E-01	1.5537E-05	1.6122E+01	2.8759E+00	-R	-R	****
6	7.1297E-01	1.1670E+03	1.4861E+02	1.7322E+01	1.8762E+00	9.9026E-01	1.5631E-05	1.6122E+01	2.8702E+00	-R	-R	****
5	6.8379E-01	1.1650E+03	1.5783E+02	1.7824E+01	1.8904E+00	9.9003E-01	1.5714E-05	1.6122E+01	2.8651E+00	-R	-R	****
4	6.5461E-01	1.1630E+03	1.6775E+02	1.8388E+01	1.9027E+00	9.9000E-01	1.5787E-05	1.6122E+01	2.8608E+00	-R	-R	****
3	6.2544E-01	1.1608E+03	1.7867E+02	1.9041E+01	1.9116E+00	9.8930E-01	1.5837E-05	1.6122E+01	2.8573E+00	-R	-R	****
2	5.9626E-01	1.1585E+03	1.9013E+02	1.9747E+01	1.9208E+00	9.8972E-01	1.5893E-05	1.6122E+01	2.8544E+00	-R	-R	****
1	5.6708E-01	1.1560E+03	2.0383E+02	2.0394E+01	1.9180E+00	9.8664E-01	1.5862E-05	1.6123E+01	2.8533E+00	-R	-R	****

STATION 272 Z IS 3.2160000E+00 C IS 1.2963169E+00 CZ IS 4.0393232E-01 CPHI IS 3.2606111E-02
B IS 5.670773E-01 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	1.2963E+00	1.2150E+03	1.0713E+02	1.5601E+01	1.1950E+00	9.9942E-01	1.1355E-05	1.6118E+01	3.1779E+00	-R	-R	****
18	1.2558E+00	1.2119E+03	1.1478E+02	1.5632E+01	1.2275E+00	9.9938E-01	1.1575E-05	1.6118E+01	3.1596E+00	-R	-R	****
17	1.2153E+00	1.2096E+03	1.2094E+02	1.5709E+01	1.2527E+00	9.9935E-01	1.1744E-05	1.6118E+01	3.1459E+00	-R	-R	****
16	1.1748E+00	1.2076E+03	1.2616E+02	1.5833E+01	1.2728E+00	9.9931E-01	1.1878E-05	1.6118E+01	3.1351E+00	-R	-R	****
15	1.1343E+00	1.2058E+03	1.3107E+02	1.5981E+01	1.2908E+00	9.9927E-01	1.1997E-05	1.6118E+01	3.1256E+00	-R	-R	****
14	1.0938E+00	1.2042E+03	1.3571E+02	1.6165E+01	1.3066E+00	9.9921E-01	1.2102E-05	1.6118E+01	3.1173E+00	-R	-R	****
13	1.0532E+00	1.2027E+03	1.4029E+02	1.6376E+01	1.3214E+00	9.9916E-01	1.2200E-05	1.6118E+01	3.1097E+00	-R	-R	****
12	1.0127E+00	1.2012E+03	1.4481E+02	1.6624E+01	1.3349E+00	9.9910E-01	1.2288E-05	1.6118E+01	3.1028E+00	-R	-R	****
11	9.7221E-01	1.1998E+03	1.4938E+02	1.6905E+01	1.3475E+00	9.9903E-01	1.2371E-05	1.6118E+01	3.0964E+00	-R	-R	****
10	9.3170E-01	1.1984E+03	1.5402E+02	1.7229E+01	1.3592E+00	9.9895E-01	1.2447E-05	1.6119E+01	3.0906E+00	-R	-R	****
9	8.9118E-01	1.1970E+03	1.5881E+02	1.7596E+01	1.3701E+00	9.9886E-01	1.2518E-05	1.6119E+01	3.0851E+00	-R	-R	****
8	8.5067E-01	1.1957E+03	1.6376E+02	1.8015E+01	1.3802E+00	9.9874E-01	1.2584E-05	1.6119E+01	3.0801E+00	-R	-R	****
7	8.1016E-01	1.1943E+03	1.6895E+02	1.8489E+01	1.3895E+00	9.9860E-01	1.2643E-05	1.6119E+01	3.0755E+00	-R	-R	****
6	7.6964E-01	1.1930E+03	1.7441E+02	1.9025E+01	1.3978E+00	9.9841E-01	1.2697E-05	1.6119E+01	3.0714E+00	-R	-R	****
5	7.2913E-01	1.1916E+03	1.8023E+02	1.9629E+01	1.4051E+00	9.9819E-01	1.2743E-05	1.6119E+01	3.0678E+00	-R	-R	****
4	6.8862E-01	1.1902E+03	1.8643E+02	2.0278E+01	1.4113E+00	9.9774E-01	1.2782E-05	1.6119E+01	3.0645E+00	-R	-R	****
3	6.4810E-01	1.1888E+03	1.9324E+02	2.0991E+01	1.4157E+00	9.9740E-01	1.2809E-05	1.6119E+01	3.0622E+00	-R	-R	****
2	6.0759E-01	1.1872E+03	2.0043E+02	2.1250E+01	1.4198E+00	9.9601E-01	1.2830E-05	1.6120E+01	3.0593E+00	-R	-R	****
1	5.6708E-01	1.1859E+03	2.0911E+02	2.2880E+01	1.4201E+00	9.9926E-01	1.2844E-05	1.6118E+01	3.0613E+00	-R	-R	****

PLANE 14 ANGLE IS 180.00 DEGREES

STATION 272 Z IS 3.2160000E+00 C IS 1.3007765E+00 CZ IS 4.0542136E-01 CPHI IS 0.
B IS 5.670773E-01 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	1.3008E+00	1.2154E+03	1.0813E+02	6.9666E-13	1.1894E+00	9.9947E-01	1.1317E-05	1.6118E+01	3.1811E+00	-R	-R	****
18	1.2600E+00	1.2123E+03	1.1581E+02	0.	1.2221E+00	9.9942E-01	1.1538E-05	1.6118E+01	3.1627E+00	-R	-R	****
17	1.2193E+00	1.2100E+03	1.2195E+02	0.	1.2472E+00	9.9939E-01	1.1707E-05	1.6118E+01	3.1489E+00	-R	-R	****
16	1.1785E+00	1.2080E+03	1.2715E+02	0.	1.2672E+00	9.9934E-01	1.1841E-05	1.6118E+01	3.1381E+00	-R	-R	****
15	1.1377E+00	1.2062E+03	1.3203E+02	0.	1.2851E+00	9.9930E-01	1.1960E-05	1.6118E+01	3.1286E+00	-R	-R	****
14	1.0970E+00	1.2046E+03	1.3663E+02	0.	1.3009E+00	9.9925E-01	1.2064E-05	1.6118E+01	3.1203E+00	-R	-R	****

Table D-1. (Continued)

13	1.0562E+00	1.2031E+03	1.4117E+02	0.	1.3155E+00	9.9919E-01	1.2161E-05	1.6118E+01	3.1127E+00	-R	-R ****
12	1.0154E+00	1.2016E+03	1.4565E+02	0.	1.3289E+00	9.9913E-01	1.2249E-05	1.6118E+01	3.1059E+00	-R	-R ****
11	9.7469E-01	1.2002E+03	1.5018E+02	0.	1.3415E+00	9.9905E-01	1.2332E-05	1.6118E+01	3.0995E+00	-R	-R ****
10	9.3393E-01	1.1988E+03	1.5478E+02	0.	1.3532E+00	9.9897E-01	1.2408E-05	1.6119E+01	3.0936E+00	-R	-R ****
9	8.9317E-01	1.1975E+03	1.5951E+02	0.	1.3641E+00	9.9887E-01	1.2479E-05	1.6119E+01	3.0881E+00	-R	-R ****
8	8.5240E-01	1.1961E+03	1.6441E+02	0.	1.3742E+00	9.9874E-01	1.2544E-05	1.6119E+01	3.0831E+00	-R	-R ****
7	8.1164E-01	1.1948E+03	1.6953E+02	0.	1.3834E+00	9.9860E-01	1.2604E-05	1.6119E+01	3.0785E+00	-R	-R ****
6	7.7088E-01	1.1934E+03	1.7492E+02	0.	1.3918E+00	9.9841E-01	1.2658E-05	1.6119E+01	3.0743E+00	-R	-R ****
5	7.3012E-01	1.1921E+03	1.8066E+02	0.	1.3992E+00	9.9815E-01	1.2705E-05	1.6119E+01	3.0705E+00	-R	-R ****
4	6.8936E-01	1.1907E+03	1.8678E+02	0.	1.4056E+00	9.9775E-01	1.2745E-05	1.6119E+01	3.0672E+00	-R	-R ****
3	6.4860E-01	1.1893E+03	1.9349E+02	0.	1.4102E+00	9.9736E-01	1.2774E-05	1.6119E+01	3.0647E+00	-R	-R ****
2	6.0784E-01	1.1877E+03	2.0061E+02	0.	1.4146E+00	9.9642E-01	1.2798E-05	1.6120E+01	3.0621E+00	-R	-R ****
1	5.6708E-01	1.1865E+03	2.0921E+02	0.	1.4153E+00	9.9983E-01	1.2815E-05	1.6118E+01	3.0640E+00	-R	-R ****

MACH NO = 3.300 ANGLE OF ATTACK = 3.000 ANGLE OF SIDESLIP = 0.000 Z0 = 0.000

S U R F A C E P R E S S U R E R A T I O

Z+Z0	0.0	15.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0	135.0	150.0	165.0	180.0
.100	2.004	1.991	1.951	1.891	1.814	1.729	1.643	1.562	1.491	1.434	1.392	1.367	1.358
.101	1.990	1.977	1.939	1.880	1.806	1.724	1.640	1.561	1.492	1.436	1.396	1.371	1.362
.103	1.976	1.964	1.927	1.870	1.799	1.719	1.638	1.561	1.494	1.439	1.399	1.375	1.367
.104	1.965	1.952	1.917	1.862	1.792	1.714	1.635	1.561	1.495	1.442	1.404	1.380	1.372
.105	1.954	1.942	1.908	1.854	1.786	1.710	1.633	1.561	1.497	1.445	1.408	1.385	1.377
.107	1.944	1.933	1.899	1.847	1.780	1.707	1.632	1.561	1.499	1.448	1.412	1.389	1.382
.108	1.936	1.924	1.891	1.840	1.775	1.703	1.630	1.561	1.500	1.451	1.415	1.393	1.386
2.980	1.930	1.918	1.882	1.828	1.760	1.688	1.616	1.552	1.500	1.461	1.435	1.420	1.415
3.017	1.930	1.918	1.882	1.828	1.760	1.688	1.616	1.552	1.500	1.461	1.435	1.420	1.415
3.055	1.930	1.918	1.882	1.828	1.760	1.688	1.616	1.552	1.500	1.461	1.435	1.420	1.415
3.094	1.930	1.918	1.882	1.828	1.760	1.688	1.616	1.552	1.500	1.461	1.435	1.420	1.415
3.133	1.930	1.918	1.882	1.828	1.760	1.688	1.616	1.552	1.500	1.461	1.435	1.420	1.415
3.172	1.930	1.918	1.882	1.828	1.760	1.688	1.616	1.552	1.500	1.461	1.435	1.420	1.415
3.212	1.930	1.918	1.882	1.828	1.760	1.688	1.616	1.552	1.500	1.461	1.435	1.420	1.415
3.216	1.930	1.918	1.882	1.828	1.760	1.688	1.616	1.552	1.500	1.461	1.435	1.420	1.415

A E R O D Y N A M I C D A T A

F R E E S T R E A M C O N D I T I O N S

MACH NO. = 3.300000E+00 ANGLE OF ATTACK = 3.000000E+00 ANGLE OF SIDESLIP = 0.
VINF = 1.234747E+03 TOTAL ANGLE OF ATTACK = 3.000000E+00 AERO ROLL ANGLE = 0.
PINF = 1.000000E+00 DINF = 1.000000E-05 SINF = 0.
PERFECT GAS (GAMMA = 1.400000E+00)

R E F E R E N C E Q U A N T I T I E S

REFERENCE LENGTH IS 3.216000E+00 REFERENCE AREA IS 1.010263E+00 Z0 IS 0.

Z+Z0	CN	CA	CY	CMN	CMM	CML	XCPP	XCPY
3.094	8.87881E-02	7.81570E-02	0.	0.	5.88040E-02	0.	6.62296E-01	-R
3.133	9.10407E-02	8.01384E-02	0.	0.	6.10525E-02	0.	6.70607E-01	-R
3.172	9.33503E-02	8.21699E-02	0.	0.	6.33869E-02	0.	6.79022E-01	-R
3.212	9.57183E-02	8.42528E-02	0.	0.	6.58105E-02	0.	6.87544E-01	-R
3.216	9.59550E-02	8.44609E-02	0.	0.	6.60544E-02	0.	6.88389E-01	-R

Table D-2. COWLI output

```
******* FREE STREAM CONDITIONS *******
        MACH NUMBER            3.3000000
        ANGLE OF ATTACK        3.0000000
        YAW ANGLE              0.0000000
        VINF               1234.7469376
        PINF                   1.0000000
        DINF                    .0000100
        HO              1112300.0000000
        SINF                  16.1180957
        PTINF                 57.2187841

******* PROBLEM SET UP *******
        NC                  19
        MC                  13
        IBODY                0
        DDZ                 0.00000
        ICOWL                1

******* CLUSTERING ********
N       CLUSTERING
1      0.0000000
2       .0555556
3       .1111111
4       .1666667
5       .2222222
6       .2777778
7       .3333333
8       .3888889
9       .4444444
10      .5000000
11      .5555556
12      .6111111
13      .6666667
14      .7222222
15      .7777778
16      .8333333
17      .8888889
18      .9444444
19     1.0000000
```

Table D-2. (Continued)

******* COWL GEOMETRY *******

N	B	BZ	BPHI	C	CZ	CPHI
1	.5670773	-R	-R	1.0000000	.0174000	0.0000000
2	.5670773	-R	-R	1.0000000	.0174000	0.0000000
3	.5670773	-R	-R	1.0000000	.0174000	0.0000000
4	.5670773	-R	-R	1.0000000	.0174000	0.0000000
5	.5670773	-R	-R	1.0000000	.0174000	0.0000000
6	.5670773	-R	-R	1.0000000	.0174000	0.0000000
7	.5670773	-R	-R	1.0000000	.0174000	0.0000000
8	.5670773	-R	-R	1.0000000	.0174000	0.0000000
9	.5670773	-R	-R	1.0000000	.0174000	0.0000000
10	.5670773	-R	-R	1.0000000	.0174000	0.0000000
11	.5670773	-R	-R	1.0000000	.0174000	0.0000000
12	.5670773	-R	-R	1.0000000	.0174000	0.0000000
13	.5670773	-R	-R	1.0000000	.0174000	0.0000000

INLET PLANE FLOW FIELD PARAMETERS

SHOCK LAYER AVERAGE PRESSURE RECOVERY RATIO	.9959060		
INLET AVERAGE PRESSURE RECOVERY RATIO	.9951207		
SHOCK LAYER CROSSECTIONAL AREA	3.4453534		
INLET ENTRANCE CROSSECTIONAL AREA	2.1313298		
MASS CAPTURED BY THE INLET	.0349651		
ADDATIVE AXIAL FORCE COEFFICIENT	.0570209	TOTAL DRAG ERROR	-.2080 O/O
ADDATIVE NORMAL FORCE COEFFICIENT	-.0170264	TOTAL NORMAL FORCE ERROR	4.6896 O/O
ADDATIVE YAW FORCE COEFFICIENT	0.0000000	TOTAL YAW FORCE ERROR	0.0000 O/O
REFERENCE AREA	1.0102628		

Table D-3. SWINT Inlet output.(z=3.216 to 5.2)

```
******* PROGRAM SWINT  DATE   83/10/25.      TIME   09.19.39.  *******

****FREE STHEAM CONDITIONS****

     MACH NUMBER          3.3000E+00
     ANGLE OF ATTACK      3.0000E+00
     ANGLE OF YAW         0.
     VINF                 1.2347E+03
     PINF                 1.0000E+00
     DINF                 1.0000E-05
     HINF                 3.5000E+05
     H0                   1.1123E+06
     SINF                 0.

**** PROBLEM SET UP****

     NC =               19        (NUMBER OF R-PLANES)
     MC =               13        (NUMBER OF PHI-PLANES)
     KA =             2000        (MAXIMUM NUMBER OF STEPS)
     ZEND =         5.2000        (MAXIMUM Z VALUE)
     FACTOR =        .9000        (CFL SAFETY FACTOR)
     PHIO =       180.0000        (MAXIMUM PHI)
     IDYAW =             0        (0-SYMMETRIC, 1-ASYMMETRIC)
     IZONE =             0        (IF IZONE .GT. 0 THEN REZONE)
     ICOWL =             1        (OUTER BOUNDARY DEFINITION. 1=WALL,0=SHOCK)
     NSFD =              0        (IF NSFD .GT. 0 USER READS IN A MESH CLUSTERED IN R - DIRECTION)
     NSGD =              0        (IF NSGD .GT. 0 USER READS IN A MESH CLUSTERED IN PHI - DIRECTION)
     JM1 =               1        (=0 DIFFERENCE USING M,M-1 , =1 USE M+1,M - FOR PREDICTOR)
     JM2 =               0        (=0 DIFFERENCE USING M,M-1 , =1 USE M+1,M - FOR CORRECTOR)
     JN1 =               1        (=0 DIFFERENCE USING N,N-1 , =1 USE N+1,N - FOR PREDICTOR)
     JN2 =               0        (=0 DIFFERENCE USING N,N-1 , =1 USE N+1,N - FOR CORRECTOR)
     ISWDIF =            0        (=1 ALLOWS DIFFERENCING OPTION TO BE SWITCHED IN SUCCESSIVE STEPS, =0 NO SWITCHING)
     ZCFL1 =       10.4000        (LOWER BOUNDARY OF INTERVAL IN WHICH CFL FACTOR IS REDUCED)
     ZCFL2 =       10.4000        (UPPER BOUNDARY OF INTERVAL IN WHICH CFL FACTOR IS REDUCED)
     KFAC =              3        (IN INTERVAL ZCFL1 TO ZCFL2, CFL FACTOR REDUCED BY KFAC)

**** OUTPUT CONTROL****

     KOUT =      40     20     20     20     20             (PRINT FREQUENCY)
     ZPRINT =  10000.00   10000.00   10000.00   10000.00   10000.00 (TRANSITION PT IN Z FOR KOUT)
     ZTARGET =    0.00    0.00    0.00    0.00    0.00      (TARGET OUTPUT STATIONS)
     NMAX =         19                                      (OUTPUT RESTICTED FOR N .LE. NMAX)
     MMIN, MMAX =          2         14                     (OUTPUT RESTRICTED FOR MMIN .LE. M .LE. MMAX)
     ZTAPE = 10000.0000                                     (PLOT TAPE WRITTEN AT EACH OUTPUT Z .GT. ZTAPE)
     DZPRINT = 10000.0000                                   (Z INTERVAL FOR FIELD OUTPUT)
     JJJJJ =         9                                      (=6 PRINT DEBUG WRITE MESSAGES, =9 NO PRINTING)
     LLLLL =         9                                      (=6 PRINT DEBUG WRITE MESSAGES, =9 NO PRINTING)
     IPCID =         0                                      (=0 PINF/P PRINTED IN OUT, =1 CP PRINTED)
     INTRE =         0                                      (NUMBER OF CONSTANT RADIAL LINES FOR FIN SURFACE PRESSURE INTERPOLATION)
     RINT =     -R    -R    -R    -R    -R    -R    -R    -R    -R  (INTERPOLATION RADII)

**** WALL OPTIONS****

     ISWSMO =       0          (ISWSMO = 1 -ENTROPY EXTRAPOLATION, =0 -STANDARD)
     ISWMOD =       0          (FORM OF BOUNDARY CONDITIONS- 0 = 14A,15A,  3 = 14C,15C)
```

Table D-3. (Continued)

```
 MODI =         0          (ORDER OF ACCURACY -- 0=1ST ORDER, 1=2ND ORDER UNTIL BODY DISCONTINUITY ENCOUNTERED)
 ISEP =         0          (0 = ON SEPARATION, 1 = SFPARATION AND INTERIOR POINT SMOOTHING)
 ZJLOW =     0.00          (LOWER BOUNDARY OF INTERVAL IN WHICH A BODY JUMP IS IGNORED)
 ZJHI =      0.00          (UPPER BOUNDARY OF INTERVAL IN WHICH A BODY JUMP IS IGNORED)
 KCFL =         0          (NUMBER OF STEPS AFTER AN EXPANSION DISCONTINUITY TO REDUCE CFL FACTOR)
 NJMPKT =       0          (MAX NUMBER OF STEPS AFTER AN EXPANSION DISCONTINUITY FOR WHICH X-DERIVATIVES AT WALL SET =0)
 NJMKTS =       4          (MAX NUMBER OF STEPS AFTER A COMPRESSION DISCONTINUITY FOR WHICH X-DERIVATIVES AT WALL SET =0)


**** COWL OPTIONS****

 ISWSMOC =      0          (ISWSMOC = 1 -ENTHOPY EXTRAPOLATION, =0-STANDARD)
 ISWMODC =      0          (FORM OF BOUNDARY CONDITIONS- 0 = 14A,15A,  3 = 14C,15C)
 MODIC =        0          (ORDER OF ACCURACY-- 0=1ST ORDER, 1=2ND ORDER UNTIL COWL DISCONTINUITY ENCOUNTERED)
 ICOWOPT =      1          (COWL NORMAL DERIVATIVE CONTROL- 0=STANDARD,1=MODIFIED FOR 4 STEPS)


**** FIN OPTIONS****

 IFIN =      0          (NUMBER OF FINS)
 NFIN =      0          (NUMBER OF FIN SURFACES)


**** SMOOTHING OPTIONS****

 ZSMON =        0.00       (IF Z .GT. ZSMON, SMOOTHING IS TURNED ON)
 ZSMOFF =   10000.00       (IF Z .GT. ZSMOFF, SMOOTHING IS TURNED OFF)

 ** INTERIOR POINTS**

 IFD =          0          (0 = NO SMOOTHING, 1 = SMOOTH)
 THCX =    0.0000          (SMOOTHING COEFFICIENT IN X DIRECTION)
 THCY =    0.0000          (SMOOTHING COEFFICIENT IN Y DIRECTION)

 ** SURFACE POINTS**

 NSMTH =     0                               (NUMBER OF SMOOTHING REGIONS)
 N9 =        0     0     0     0     0     0     0     0     0     (OUTER N-LIMIT FOR SMOOTHING)
 M8 =        0     0     0     0               (LOWER M-LIMIT FOR SMOOTHING)
 M9 =        0     0     0     0               (UPPER M-LIMIT FOR SMOOTHING)
 X9 =     0.00  0.00  0.00  0.00               (.GT. 0 SMOOTHING CONSTANT, .LT. 0 ABS MULTIPLIED BY DENSITY SWITCH)


 MACH NO IS  3.3000000E+00     ANGLE OF ATTACK IS  3.0000000E+00     ANGLE OF SIDESLIP IS  0.

 PRESSURE RECOVERY   PTAVR/PTINF =     .99495

 PLANE   2   ANGLE IS   0.00 DEGREES

 STATION    0    Z IS  3.2160000E+00    C IS  1.0000346E+00    CZ IS  1.7305785E-02    CPHI IS  0.
 B IS  5.6707773E-01  BZ IS  1.763300E-01  BPHI IS  0.           BZZ IS  0.              BZPHI IS  0.          BPHPHI IS  0.

  N     R           W           U         V       P           PT/PTINF    RHO         S           M              TR          TZ    IS
 19  1.0000E+00  1.1674E+03  2.0312E+01  0.        2.0461E+00  9.8979E-01  1.6627E-05  1.6122E+01  2.8129E+00      -R          -R ****
 18  9.7598E-01  1.1839E+03  8.1845E+01  0.        1.6956E+00  9.9059E-01  1.4542E-05  1.6122E+01  2.9373E+00      -R          -R ****
 17  9.5193E-01  1.1823E+03  8.7330E+01  0.        1.7171E+00  9.9055E-01  1.4674E-05  1.6122E+01  2.9290E+00      -R          -R ****
 16  9.2788E-01  1.1807E+03  9.2819E+01  0.        1.7377E+00  9.9052E-01  1.4799E-05  1.6122E+01  2.9210E+00      -R          -R ****
```

Table D-3. (Continued)

15	9.0382E-01	1.1791E+03	9.8348E+01	0.	1.7574E+00	9.9048E-01	1.4918E-05	1.6122E+01	2.9136E+00	-R	-R	****
14	8.7977E-01	1.1776E+03	1.0395E+02	0.	1.7764E+00	9.9045E-01	1.5033E-05	1.6122E+01	2.9064E+00	-R	-R	****
13	8.5572E-01	1.1760E+03	1.0966E+02	0.	1.7946E+00	9.9041E-01	1.5143E-05	1.6122E+01	2.8997E+00	-R	-R	****
12	8.3166E-01	1.1745E+03	1.1554E+02	0.	1.8120E+00	9.9036E-01	1.5247E-05	1.6122E+01	2.8933E+00	-R	-R	****
11	8.0761E-01	1.1729E+03	1.2161E+02	0.	1.8287E+00	9.9030E-01	1.5347E-05	1.6122E+01	2.8872E+00	-R	-R	****
10	7.8356E-01	1.1714E+03	1.2791E+02	0.	1.8445E+00	9.9024E-01	1.5442E-05	1.6122E+01	2.8814E+00	-R	-R	****
9	7.5950E-01	1.1698E+03	1.3447E+02	0.	1.8597E+00	9.9017E-01	1.5532E-05	1.6122E+01	2.8760E+00	-R	-R	****
8	7.3545E-01	1.1682E+03	1.4132E+02	0.	1.8740E+00	9.9009E-01	1.5617E-05	1.6122E+01	2.8709E+00	-R	-R	****
7	7.1140E-01	1.1665E+03	1.4851E+02	0.	1.8874E+00	9.9001E-01	1.5697E-05	1.6122E+01	2.8661E+00	-R	-R	****
6	6.8734E-01	1.1649E+03	1.5619E+02	0.	1.8994E+00	9.8983E-01	1.5767E-05	1.6122E+01	2.8618E+00	-R	-R	****
5	6.6329E-01	1.1632E+03	1.6435E+02	0.	1.9102E+00	9.8979E-01	1.5830E-05	1.6122E+01	2.8581E+00	-R	-R	****
4	6.3924E-01	1.1614E+03	1.7313E+02	0.	1.9189E+00	9.8944E-01	1.5881E-05	1.6122E+01	2.8549E+00	-R	-R	****
3	6.1518E-01	1.1595E+03	1.8242E+02	0.	1.9267E+00	9.8930E-01	1.5926E-05	1.6122E+01	2.8521E+00	-R	-R	****
2	5.9113E-01	1.1576E+03	1.9236E+02	0.	1.9325E+00	9.8912E-01	1.5959E-05	1.6122E+01	2.8500E+00	-R	-R	****
1	5.6708E-01	1.1555E+03	2.0374E+02	0.	1.9305E+00	9.8660E-01	1.5936E-05	1.6123E+01	2.8490E+00	-R	-R	****

PLANE 3 ANGLE IS 15.00 DEGREES

STATION 0 Z IS 3.2160000E+00 C IS 1.0000346E+00 CZ IS 1.7305785E-02 CPHI IS 0.
B IS 5.670773E-01 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	1.0000E+00	1.1672E+03	2.0309E+01	1.4737E+01	2.0486E+00	9.9000E-01	1.6642E-05	1.6122E+01	2.8123E+00	-R	-R	****
18	9.7598E-01	1.1842E+03	8.3102E+01	1.4839E+01	1.6893E+00	9.9087E-01	1.4505E-05	1.6122E+01	2.9400E+00	-R	-R	****
17	9.5193E-01	1.1825E+03	8.8522E+01	1.4961E+01	1.7104E+00	9.9083E-01	1.4634E-05	1.6122E+01	2.9317E+00	-R	-R	****
16	9.2788E-01	1.1809E+03	9.3951E+01	1.5099E+01	1.7306E+00	9.9079E-01	1.4757E-05	1.6122E+01	2.9239E+00	-R	-R	****
15	9.0382E-01	1.1794E+03	9.9424E+01	1.5254E+01	1.7499E+00	9.9075E-01	1.4874E-05	1.6122E+01	2.9166E+00	-R	-R	****
14	8.7977E-01	1.1778E+03	1.0497E+02	1.5428E+01	1.7684E+00	9.9071E-01	1.4986E-05	1.6122E+01	2.9096E+00	-R	-R	****
13	8.5572E-01	1.1763E+03	1.1063E+02	1.5622E+01	1.7863E+00	9.9067E-01	1.5094E-05	1.6122E+01	2.9029E+00	-R	-R	****
12	8.3166E-01	1.1748E+03	1.1644E+02	1.5839E+01	1.8034E+00	9.9062E-01	1.5197E-05	1.6122E+01	2.8966E+00	-R	-R	****
11	8.0761E-01	1.1732E+03	1.2246E+02	1.6084E+01	1.8197E+00	9.9056E-01	1.5294E-05	1.6122E+01	2.8906E+00	-R	-R	****
10	7.8356E-01	1.1717E+03	1.2870E+02	1.6354E+01	1.8352E+00	9.9049E-01	1.5387E-05	1.6122E+01	2.8849E+00	-R	-R	****
9	7.5950E-01	1.1701E+03	1.3520E+02	1.6654E+01	1.8500E+00	9.9041E-01	1.5475E-05	1.6122E+01	2.8796E+00	-R	-R	****
8	7.3545E-01	1.1686E+03	1.4199E+02	1.6985E+01	1.8639E+00	9.9033E-01	1.5558E-05	1.6122E+01	2.8746E+00	-R	-R	****
7	7.1140E-01	1.1669E+03	1.4911E+02	1.7350E+01	1.8770E+00	9.9024E-01	1.5635E-05	1.6122E+01	2.8700E+00	-R	-R	****
6	6.8734E-01	1.1653E+03	1.5671E+02	1.7763E+01	1.8887E+00	9.9006E-01	1.5704E-05	1.6122E+01	2.8657E+00	-R	-R	****
5	6.6329E-01	1.1636E+03	1.6480E+02	1.8220E+01	1.8991E+00	9.9000E-01	1.5766E-05	1.6122E+01	2.8621E+00	-R	-R	****
4	6.3924E-01	1.1618E+03	1.7351E+02	1.8732E+01	1.9074E+00	9.8963E-01	1.5813E-05	1.6122E+01	2.8589E+00	-R	-R	****
3	6.1518E-01	1.1600E+03	1.8270E+02	1.9289E+01	1.9149E+00	9.8945E-01	1.5857E-05	1.6122E+01	2.8563E+00	-R	-R	****
2	5.9113E-01	1.1580E+03	1.9254E+02	1.9861E+01	1.9203E+00	9.8918E-01	1.5888E-05	1.6122E+01	2.8542E+00	-R	-R	****
1	5.6708E-01	1.1560E+03	2.0383E+02	2.0394E+01	1.9180E+00	9.8664E-01	1.5862E-05	1.6123E+01	2.8533E+00	-R	-R	****

PLANE 13 ANGLE IS 165.00 DEGREES

STATION 0 Z IS 3.2160000E+00 C IS 1.0000346E+00 CZ IS 1.7305785E-02 CPHI IS 0.
B IS 5.670773E-01 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	1.0000E+00	1.1640E+03	2.0254E+01	1.6712E+01	2.1094E+00	9.8959E-01	1.6992E-05	1.6122E+01	2.7929E+00	-R	-R	****
18	9.7598E-01	1.1999E+03	1.4896E+02	1.6879E+01	1.3463E+00	9.9904E-01	1.2363E-05	1.6118E+01	3.0970E+00	-R	-R	****
17	9.5193E-01	1.1991E+03	1.5171E+02	1.7067E+01	1.3534E+00	9.9898E-01	1.2409E-05	1.6119E+01	3.0935E+00	-R	-R	****
16	9.2788E-01	1.1983E+03	1.5448E+02	1.7264E+01	1.3602E+00	9.9894E-01	1.2454E-05	1.6119E+01	3.0901E+00	-R	-R	****
15	9.0382E-01	1.1975E+03	1.5732E+02	1.7482E+01	1.3667E+00	9.9888E-01	1.2496E-05	1.6119E+01	3.0868E+00	-R	-R	****
14	8.7977E-01	1.1967E+03	1.6021E+02	1.7714E+01	1.3730E+00	9.9882E-01	1.2537E-05	1.6119E+01	3.0837E+00	-R	-R	****
13	8.5572E-01	1.1959E+03	1.6315E+02	1.7963E+01	1.3790E+00	9.9875E-01	1.2576E-05	1.6119E+01	3.0807E+00	-R	-R	****
12	8.3166E-01	1.1951E+03	1.6620E+02	1.8238E+01	1.3846E+00	9.9867E-01	1.2612E-05	1.6119E+01	3.0780E+00	-R	-R	****
11	8.0761E-01	1.1942E+03	1.6929E+02	1.8523E+01	1.3900E+00	9.9859E-01	1.2647E-05	1.6119E+01	3.0753E+00	-R	-R	****
10	7.8356E-01	1.1934E+03	1.7254E+02	1.8842E+01	1.3949E+00	9.9847E-01	1.2678E-05	1.6119E+01	3.0728E+00	-R	-R	****
9	7.5950E-01	1.1926E+03	1.7587E+02	1.9177E+01	1.3996E+00	9.9835E-01	1.2708E-05	1.6119E+01	3.0705E+00	-R	-R	****
8	7.3545E-01	1.1918E+03	1.7932E+02	1.9535E+01	1.4039E+00	9.9822E-01	1.2736E-05	1.6119E+01	3.0683E+00	-R	-R	****
7	7.1140E-01	1.1910E+03	1.8294E+02	1.9913E+01	1.4078E+00	9.9799E-01	1.2760E-05	1.6119E+01	3.0663E+00	-R	-R	****

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
6	6.8734E-01	1.1901E+03	1.8665E+02	2.0301E+01	1.4114E+00	9.9773E-01	1.2783E-05	1.6119E+01	3.0644E+00	-R	-R	****
5	6.6329E-01	1.1893E+03	1.9069E+02	2.0724E+01	1.4140E+00	9.9753E-01	1.2799E-05	1.6119E+01	3.0631E+00	-R	-R	****
4	6.3924E-01	1.1884E+03	1.9482E+02	2.1048E+01	1.4166E+00	9.9709E-01	1.2814E-05	1.6119E+01	3.0616E+00	-R	-R	****
3	6.1518E-01	1.1875E+03	1.9909E+02	2.1202E+01	1.4190E+00	9.9627E-01	1.2826E-05	1.6120E+01	3.0598E+00	-R	-R	****
2	5.9113E-01	1.1867E+03	2.0396E+02	2.1912E+01	1.4199E+00	9.9733E-01	1.2836E-05	1.6119E+01	3.0601E+00	-R	-R	****
1	5.6708E-01	1.1859E+03	2.0911E+02	2.2880E+01	1.4201E+00	9.9926E-01	1.2844E-05	1.6118E+01	3.0613E+00	-R	-R	****

PLANE 14 ANGLE IS 180.00 DEGREES

STATION 0 Z IS 3.2160000E+00 C IS 1.0000346E+00 CZ IS 1.7305785E-02 CPHI IS 0.
B IS 5.670773E-01 BZ IS 1.763300E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	1.0000E+00	1.1641E+03	2.0255E+01	0.	2.1098E+00	9.8935E-01	1.6993E-05	1.6122E+01	2.7925E+00	-R	-R	****
18	9.7598E-01	1.2003E+03	1.5004E+02	0.	1.3411E+00	9.9906E-01	1.2329E-05	1.6118E+01	3.0997E+00	-R	-R	****
17	9.5193E-01	1.1995E+03	1.5275E+02	0.	1.3480E+00	9.9900E-01	1.2374E-05	1.6118E+01	3.0962E+00	-R	-R	****
16	9.2788E-01	[illegible]	[illegible]	0.	1.3548E+00	9.9895E-01	1.2418E-05	1.6119E+01	3.0928E+00	-R	-R	****
15	9.0382E-01	1.1978E+03	1.5827E+02	0.	1.3612E+00	9.9889E-01	1.2460E-05	1.6119E+01	3.0895E+00	-R	-R	****
14	8.7977E-01	1.1970E+03	1.6112E+02	0.	1.3674E+00	9.9882E-01	1.2500E-05	1.6119E+01	3.0864E+00	-R	-R	****
13	8.5572E-01	1.1962E+03	1.6401E+02	0.	1.3733E+00	9.9875E-01	1.2539E-05	1.6119E+01	3.0835E+00	-R	-R	****
12	8.3166E-01	1.1955E+03	1.6702E+02	0.	1.3789E+00	9.9867E-01	1.2575E-05	1.6119E+01	3.0807E+00	-R	-R	****
11	8.0761E-01	1.1947E+03	1.7007E+02	0.	1.3843E+00	9.9858E-01	1.2609E-05	1.6119E+01	3.0780E+00	-R	-R	****
10	7.8356E-01	1.1939E+03	1.7325E+02	0.	1.3892E+00	9.9846E-01	1.2641E-05	1.6119E+01	3.0756E+00	-R	-R	****
9	7.5950E-01	1.1931E+03	1.7653E+02	0.	1.3939E+00	9.9833E-01	1.2671E-05	1.6119E+01	3.0732E+00	-R	-R	****
8	7.3545E-01	1.1923E+03	1.7991E+02	0.	1.3982E+00	9.9818E-01	1.2699E-05	1.6119E+01	3.0710E+00	-R	-R	****
7	7.1140E-01	1.1914E+03	1.8347E+02	0.	1.4021E+00	9.9796E-01	1.2723E-05	1.6119E+01	3.0690E+00	-R	-R	****
6	6.8734E-01	1.1906E+03	1.8712E+02	0.	1.4058E+00	9.9773E-01	1.2746E-05	1.6119E+01	3.0671E+00	-R	-R	****
5	6.6329E-01	1.1898E+03	1.9107E+02	0.	1.4086E+00	9.9750E-01	1.2763E-05	1.6119E+01	3.0656E+00	-R	-R	****
4	6.3924E-01	1.1889E+03	1.9513E+02	0.	1.4112E+00	9.9714E-01	1.2779E-05	1.6119E+01	3.0641E+00	-R	-R	****
3	6.1518E-01	1.1880E+03	1.9933E+02	0.	1.4138E+00	9.9659E-01	1.2794E-05	1.6119E+01	3.0625E+00	-R	-R	****
2	5.9113E-01	1.1872E+03	2.0414E+02	0.	1.4148E+00	9.9782E-01	1.2805E-05	1.6119E+01	3.0629E+00	-R	-R	****
1	5.6708E-01	1.1865E+03	2.0921E+02	0.	1.4153E+00	9.9983E-01	1.2815E-05	1.6118E+01	3.0640E+00	-R	-R	****

STEP= 1 DZ= 4.6772346E-02 CFL= 1.0690077E+00 N,M,J= 18 13 3 Z= 3.2627723E+00 OPTIONS= 0 0 0 JS= 1 1 0 0

STEP= 2 DZ= 4.6337412E-02 CFL= 1.0790417E+00 N,M,J= 17 13 3 Z= 3.3091098E+00 OPTIONS= 0 0 0 JS= 1 1 0 0

STEP= 3 DZ= 4.5923408E-02 CFL= 1.0887694E+00 N,M,J= 16 13 3 Z= 3.3550332E+00 OPTIONS= 0 0 0 JS= 1 1 0 0

STEP= 4 DZ= 4.5509496E-02 CFL= 1.0986718E+00 N,M,J= 15 12 3 Z= 3.4005427E+00 OPTIONS= 0 0 0 JS= 1 1 0 0

STEP= 5 DZ= 4.4940005E-02 CFL= 1.1125945E+00 N,M,J= 15 12 3 Z= 3.4454827E+00 OPTIONS= 0 0 0 JS= 1 1 0 0

MACH NO IS 3.3000000E+00 ANGLE OF ATTACK IS 3.0000000E+00 ANGLE OF SIDESLIP IS 0.

PRESSURE RECOVERY PTAVR/PTINF = .98056

PLANE 2 ANGLE IS 0.00 DEGREES

STATION 151 Z IS 5.2000000E+00 C IS 8.5233200E-01 CZ IS -2.2000000E-02 CPHI IS 0.
B IS 6.974500E-01 BZ IS -1.455000E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	8.5233E-01	9.8490E+02	-2.1668E+01	0.	7.6185E+00	9.8979E-01	4.2524E-05	1.6122E+01	1.9670E+00	-R	-R	****
18	8.4373E-01	9.8285E+02	-1.8726E+01	0.	7.6323E+00	9.8018E-01	4.2460E-05	1.6126E+01	1.9596E+00	-R	-R	****
17	8.3512E-01	9.8053E+02	-1.9059E+01	0.	7.7729E+00	9.8574E-01	4.3087E-05	1.6124E+01	1.9515E+00	-R	-R	****
16	8.2652E-01	9.7478E+02	-2.6004E+01	0.	8.0169E+00	9.8646E-01	4.4058E-05	1.6124E+01	1.9320E+00	-R	-R	****
15	8.1791E-01	9.6974E+02	-3.6107E+01	0.	8.2263E+00	9.8713E-01	4.4886E-05	1.6123E+01	1.9158E+00	-R	-R	****
14	8.0931E-01	9.6757E+02	-4.6400E+01	0.	8.3048E+00	9.8749E-01	4.5196E-05	1.6123E+01	1.9099E+00	-R	-R	****
13	8.0070E-01	9.6759E+02	-5.6526E+01	0.	8.2802E+00	9.8745E-01	4.5100E-05	1.6123E+01	1.9118E+00	-R	-R	****

Table D-3. (Continued)

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
12	7.9210E-01	9.6846E+02	-6.6366E+01	0.	8.2138E+00	9.8728E-01	4.4839E-05	1.6123E+01	1.9169E+00	-R	-R	****
11	7.8350E-01	9.6920E+02	-7.5673E+01	0.	8.1511E+00	9.8717E-01	4.4593E-05	1.6123E+01	1.9217E+00	-R	-R	****
10	7.7489E-01	9.6916E+02	-8.4834E+01	0.	8.1202E+00	9.8716E-01	4.4472E-05	1.6123E+01	1.9242E+00	-R	-R	****
9	7.6629E-01	9.6829E+02	-9.4321E+01	0.	8.1197E+00	9.8715E-01	4.4470E-05	1.6123E+01	1.9242E+00	-R	-R	****
8	7.5768E-01	9.6693E+02	-1.0356E+02	0.	8.1358E+00	9.8696E-01	4.4530E-05	1.6123E+01	1.9228E+00	-R	-R	****
7	7.4908E-01	9.6463E+02	-1.0972E+02	0.	8.2061E+00	9.8700E-01	4.4806E-05	1.6123E+01	1.9173E+00	-R	-R	****
6	7.4047E-01	9.5882E+02	-1.0746E+02	0.	8.4633E+00	9.8619E-01	4.5793E-05	1.6124E+01	1.8968E+00	-R	-R	****
5	7.3187E-01	9.4857E+02	-9.6460E+01	0.	8.9625E+00	9.8503E-01	4.7691E-05	1.6124E+01	1.8589E+00	-R	-R	****
4	7.2326E-01	9.3982E+02	-9.0086E+01	0.	9.3900E+00	9.8481E-01	4.9302E-05	1.6124E+01	1.8284E+00	-R	-R	****
3	7.1466E-01	9.3704E+02	-9.8187E+01	0.	9.4657E+00	9.8318E-01	4.9562E-05	1.6125E+01	1.8221E+00	-R	-R	****
2	7.0605E-01	9.3635E+02	-1.1575E+02	0.	9.3546E+00	9.7795E-01	4.9071E-05	1.6127E+01	1.8263E+00	-R	-R	****
1	6.9745E-01	9.3696E+02	-1.3633E+02	0.	9.2816E+00	9.8660E-01	4.8920E-05	1.6123E+01	1.8371E+00	-R	-R	****

PLANE 3 ANGLE IS 15.00 DEGREES

STATION 151 Z IS 5.2000000E+00 C IS 8.5233200E-01 CZ IS -2.2000000E-02 CPHI IS 0.
B IS 6.974500E-01 BZ IS -1.455000E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	8.5233E-01	9.8430E+02	-2.1654E+01	1.5778E+01	7.6398E+00	9.8996E-01	4.2611E-05	1.6122E+01	1.9654E+00	-R	-R	****
18	8.4373E-01	9.8220E+02	-1.8713E+01	1.5288E+01	7.6531E+00	9.8000E-01	4.2541E-05	1.6126E+01	1.9577E+00	-R	-R	****
17	8.3512E-01	9.7996E+02	-1.9068E+01	1.5448E+01	7.7916E+00	9.8573E-01	4.3161E-05	1.6124E+01	1.9499E+00	-R	-R	****
16	8.2652E-01	9.7428E+02	-2.6066E+01	1.5583E+01	8.0333E+00	9.8649E-01	4.4123E-05	1.6124E+01	1.9307E+00	-R	-R	****
15	8.1791E-01	9.6928E+02	-3.6250E+01	1.5730E+01	8.2411E+00	9.8720E-01	4.4944E-05	1.6123E+01	1.9147E+00	-R	-R	****
14	8.0931E-01	9.6713E+02	-4.6608E+01	1.5886E+01	8.3186E+00	9.8756E-01	4.5251E-05	1.6123E+01	1.9089E+00	-R	-R	****
13	8.0070E-01	9.6714E+02	-5.6768E+01	1.6045E+01	8.2940E+00	9.8752E-01	4.5154E-05	1.6123E+01	1.9107E+00	-R	-R	****
12	7.9210E-01	9.6799E+02	-6.6621E+01	1.6219E+01	8.2282E+00	9.8735E-01	4.4896E-05	1.6123E+01	1.9158E+00	-R	-R	****
11	7.8350E-01	9.6870E+02	-7.5930E+01	1.6403E+01	8.1663E+00	9.8724E-01	4.4653E-05	1.6123E+01	1.9206E+00	-R	-R	****
10	7.7489E-01	9.6864E+02	-8.5093E+01	1.6579E+01	8.1360E+00	9.8722E-01	4.4535E-05	1.6123E+01	1.9230E+00	-R	-R	****
9	7.6629E-01	9.6775E+02	-9.4583E+01	1.6755E+01	8.1362E+00	9.8721E-01	4.4535E-05	1.6123E+01	1.9229E+00	-R	-R	****
8	7.5768E-01	9.6634E+02	-1.0377E+02	1.6942E+01	8.1545E+00	9.8701E-01	4.4604E-05	1.6123E+01	1.9214E+00	-R	-R	****
7	7.4908E-01	9.6391E+02	-1.0967E+02	1.7117E+01	8.2315E+00	9.8704E-01	4.4905E-05	1.6123E+01	1.9153E+00	-R	-R	****
6	7.4047E-01	9.5783E+02	-1.0681E+02	1.7269E+01	8.5032E+00	9.8616E-01	4.5947E-05	1.6124E+01	1.8937E+00	-R	-R	****
5	7.3187E-01	9.4742E+02	-9.5359E+01	1.7358E+01	9.0124E+00	9.8499E-01	4.7880E-05	1.6124E+01	1.8552E+00	-R	-R	****
4	7.2326E-01	9.3895E+02	-8.9343E+01	1.7421E+01	9.4258E+00	9.8478E-01	4.9436E-05	1.6124E+01	1.8259E+00	-R	-R	****
3	7.1466E-01	9.3657E+02	-9.8007E+01	1.7533E+01	9.4795E+00	9.8304E-01	4.9611E-05	1.6125E+01	1.8210E+00	-R	-R	****
2	7.0605E-01	9.3611E+02	-1.1572E+02	1.7637E+01	9.3560E+00	9.7769E-01	4.9072E-05	1.6127E+01	1.8260E+00	-R	-R	****
1	6.9745E-01	9.3680E+02	-1.3630E+02	1.7540E+01	9.2818E+00	9.8663E-01	4.8921E-05	1.6123E+01	1.8371E+00	-R	-R	****

PLANE 13 ANGLE IS 165.00 DEGREES

STATION 151 Z IS 5.2000000E+00 C IS 8.5233200E-01 CZ IS -2.2000000E-02 CPHI IS 0.
B IS 6.974500E-01 BZ IS -1.455000E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	8.5233E-01	9.2668E+02	-2.0387E+01	1.9394E+01	1.0249E+01	9.8966E-01	5.2557E-05	1.6122E+01	1.7743E+00	-R	-R	****
18	8.4373E-01	9.2033E+02	-2.6172E+01	1.3517E+01	1.0207E+01	9.5676E-01	5.1900E-05	1.6136E+01	1.7548E+00	-R	-R	****
17	8.3512E-01	9.2488E+02	-3.2015E+01	1.3654E+01	1.0111E+01	9.6904E-01	5.1736E-05	1.6131E+01	1.7695E+00	-R	-R	****
16	8.2652E-01	9.2540E+02	-3.9274E+01	1.3892E+01	1.0111E+01	9.7277E-01	5.1795E-05	1.6129E+01	1.7719E+00	-R	-R	****
15	8.1791E-01	9.2148E+02	-4.4684E+01	1.3959E+01	1.0304E+01	9.7424E-01	5.2520E-05	1.6129E+01	1.7605E+00	-R	-R	****
14	8.0931E-01	9.1169E+02	-3.8124E+01	1.3824E+01	1.0793E+01	9.7381E-01	5.4282E-05	1.6129E+01	1.7297E+00	-R	-R	****
13	8.0070E-01	8.9614E+02	-1.9668E+01	1.3285E+01	1.1586E+01	9.7215E-01	5.7076E-05	1.6129E+01	1.6816E+00	-R	-R	****
12	7.9210E-01	8.8781E+02	-1.1752E+01	1.2607E+01	1.2029E+01	9.7260E-01	5.8634E-05	1.6129E+01	1.6569E+00	-R	-R	****
11	7.8350E-01	8.8965E+02	-2.0367E+01	1.2505E+01	1.1921E+01	9.7221E-01	5.8250E-05	1.6129E+01	1.6627E+00	-R	-R	****
10	7.7489E-01	8.9475E+02	-3.4852E+01	1.2825E+01	1.1639E+01	9.7259E-01	5.7269E-05	1.6129E+01	1.6789E+00	-R	-R	****
9	7.6629E-01	8.9780E+02	-4.8305E+01	1.3087E+01	1.1453E+01	9.7271E-01	5.6616E-05	1.6129E+01	1.6896E+00	-R	-R	****
8	7.5768E-01	8.9719E+02	-5.8410E+01	1.3117E+01	1.1456E+01	9.7292E-01	5.6629E-05	1.6129E+01	1.6896E+00	-R	-R	****
7	7.4908E-01	8.9392E+02	-6.6745E+01	1.2962E+01	1.1596E+01	9.7314E-01	5.7126E-05	1.6129E+01	1.6817E+00	-R	-R	****
6	7.4047E-01	8.8969E+02	-7.6003E+01	1.2727E+01	1.1752E+01	9.7125E-01	5.7641E-05	1.6130E+01	1.6715E+00	-R	-R	****

Table D-3. (Continued)

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
5	7.3187E-01	8.8631E+02	-8.7159E+01	1.2560E+01	1.1846E+01	9.6908E-01	5.7935E-05	1.6131E+01	1.6647E+00	-R	-R	****
4	7.2326E-01	8.8391E+02	-9.9045E+01	1.2284E+01	1.1869E+01	9.6615E-01	5.7966E-05	1.6132E+01	1.6614E+00	-R	-R	****
3	7.1466E-01	8.8178E+02	-1.0998E+02	1.1721E+01	1.1841E+01	9.6032E-01	5.7766E-05	1.6134E+01	1.6589E+00	-R	-R	****
2	7.0605E-01	8.7952E+02	-1.1899E+02	1.1506E+01	1.1783E+01	9.5119E-01	5.7409E-05	1.6138E+01	1.6558E+00	-R	-R	****
1	6.9745E-01	8.8977E+02	-1.2946E+02	1.2534E+01	1.1760E+01	9.9893E-01	5.8136E-05	1.6119E+01	1.6898E+00	-R	-R	****

PLANE 14 ANGLE IS 180.00 DEGREES

STATION 151 Z IS 5.2000000E+00 C IS 8.5233200E-01 CZ IS -2.2000000E-02 CPHI IS 0.
B IS 6.974500E-01 BZ IS -1.455000E-01 BPHI IS 0. BZZ IS 0. BZPHI IS 0. BPHPHI IS 0.

N	R	W	U	V	P	PT/PTINF	RHO	S	M	TR	TZ	IS
19	8.5233E-01	9.2589E+02	-2.0370E+01	0.	1.0294E+01	9.8935E-01	5.2717E-05	1.6122E+01	1.7713E+00	-R	-R	****
18	8.4373E-01	9.1933E+02	-2.6460E+01	0.	1.0256E+01	9.5635E-01	5.2069E-05	1.6136E+01	1.7514E+00	-R	-R	****
17	8.3512E-01	9.2356E+02	-3.2358E+01	0.	1.0172E+01	9.6844E-01	5.1951E-05	1.6131E+01	1.7651E+00	-R	-R	****
16	8.2652E-01	9.2346E+02	-3.8891E+01	0.	1.0204E+01	9.7221E-01	5.2127E-05	1.6129E+01	1.7655E+00	-R	-R	****
15	8.1791E-01	9.1769E+02	-4.1557E+01	0.	1.0494E+01	9.7370E-01	5.3203E-05	1.6129E+01	1.7481E+00	-R	-R	****
14	8.0931E-01	9.0432E+02	-3.0066E+01	0.	1.1168E+01	9.7268E-01	5.5604E-05	1.6129E+01	1.7064E+00	-R	-R	****
13	8.0070E-01	8.8919E+02	-1.2250E+01	0.	1.1952E+01	9.7176E-01	5.8349E-05	1.6130E+01	1.6606E+00	-R	-R	****
12	7.9210E-01	8.8563E+02	-1.0693E+01	0.	1.2142E+01	9.7212E-01	5.9018E-05	1.6129E+01	1.6503E+00	-R	-R	****
11	7.8350E-01	8.8974E+02	-2.2215E+01	0.	1.1908E+01	9.7137E-01	5.8190E-05	1.6130E+01	1.6628E+00	-R	-R	****
10	7.7489E-01	8.9485E+02	-3.6489E+01	0.	1.1626E+01	9.7179E-01	5.7210E-05	1.6130E+01	1.6791E+00	-R	-R	****
9	7.6629E-01	8.9705E+02	-4.8473E+01	0.	1.1487E+01	9.7202E-01	5.6724E-05	1.6129E+01	1.6872E+00	-R	-R	****
8	7.5768E-01	8.9582E+02	-5.7443E+01	0.	1.1525E+01	9.7221E-01	5.6862E-05	1.6129E+01	1.6851E+00	-R	-R	****
7	7.4908E-01	8.9254E+02	-6.5632E+01	0.	1.1666E+01	9.7237E-01	5.7359E-05	1.6129E+01	1.6772E+00	-R	-R	****
6	7.4047E-01	8.8856E+02	-7.5303E+01	0.	1.1805E+01	9.7023E-01	5.7810E-05	1.6130E+01	1.6678E+00	-R	-R	****
5	7.3187E-01	8.8540E+02	-8.6804E+01	0.	1.1888E+01	9.6816E-01	5.8066E-05	1.6131E+01	1.6617E+00	-R	-R	****
4	7.2326E-01	8.8292E+02	-9.8840E+01	0.	1.1912E+01	9.6503E-01	5.8095E-05	1.6132E+01	1.6582E+00	-R	-R	****
3	7.1466E-01	8.8071E+02	-1.0985E+02	0.	1.1890E+01	9.5952E-01	5.7924E-05	1.6135E+01	1.6556E+00	-R	-R	****
2	7.0605E-01	8.7830E+02	-1.1887E+02	0.	1.1839E+01	9.5040E-01	5.7591E-05	1.6138E+01	1.6521E+00	-R	-R	****
1	6.9745E-01	8.8897E+02	-1.2935E+02	0.	1.1817E+01	9.9983E-01	5.8353E-05	1.6118E+01	1.6871E+00	-R	-R	****

MACH NO = 3.300 ANGLE OF ATTACK = 3.000 ANGLE OF SIDESLIP = 0.000 Z0 = 0.000

S U R F A C E P R E S S U R E R A T I O

Z+Z0	0.0	15.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0	135.0	150.0	165.0	180.0
5.112	8.507	8.513	8.541	8.620	8.820	9.325	10.628	13.068	14.250	14.001	13.970	14.241	14.365
5.119	8.565	8.581	8.638	8.793	9.167	10.056	11.847	13.605	13.737	13.494	13.729	14.096	14.225
5.126	8.807	8.843	8.962	9.260	9.913	11.174	12.765	13.381	13.157	13.130	13.595	13.984	14.105
5.133	9.316	9.383	9.593	10.068	10.933	12.112	12.894	12.873	12.664	12.918	13.502	13.858	13.962
5.141	10.057	10.153	10.432	10.975	11.732	12.379	12.528	12.333	12.299	12.794	13.381	13.678	13.766
5.148	10.763	10.858	11.113	11.522	11.928	12.106	12.006	11.855	12.050	12.682	13.194	13.437	13.510
5.156	11.102	11.166	11.324	11.524	11.647	11.615	11.482	11.470	11.873	12.524	12.943	13.146	13.208
5.164	11.010	11.040	11.111	11.173	11.168	11.087	11.019	11.175	11.713	12.304	12.651	12.830	12.887
5.172	10.658	10.669	10.692	10.694	10.655	10.600	10.637	10.944	11.533	12.044	12.351	12.522	12.578
5.181	10.214	10.215	10.219	10.206	10.178	10.183	10.331	10.746	11.325	11.775	12.070	12.244	12.300
5.189	9.766	9.765	9.766	9.760	9.766	9.841	10.084	10.560	11.105	11.524	11.826	12.006	12.064
5.198	9.357	9.357	9.363	9.376	9.422	9.562	9.878	10.379	10.893	11.308	11.618	11.800	11.858
5.200	9.282	9.282	9.289	9.305	9.359	9.511	9.840	10.345	10.853	11.267	11.579	11.760	11.817

Table D-3.(Continued)

MACH NO = 3.300 ANGLE OF ATTACK = 3.000 ANGLE OF SIDESLIP = 0.000 ZO = 0.000

C O W L P R E S S U R E R A T I O

Z+ZO	0.0	15.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0	135.0	150.0	165.0	180.0
5.112	9.025	9.048	9.117	9.235	9.404	9.620	9.866	10.121	10.375	10.629	10.860	11.025	11.086
5.119	8.883	8.905	8.971	9.085	9.246	9.452	9.686	9.935	10.196	10.471	10.726	10.911	10.979
5.126	8.735	8.757	8.821	8.930	9.085	9.282	9.508	9.759	10.039	10.341	10.626	10.834	10.911
5.133	8.591	8.612	8.675	8.781	8.931	9.121	9.347	9.609	9.914	10.251	10.571	10.803	10.889
5.141	8.455	8.475	8.536	8.640	8.787	8.977	9.208	9.489	9.826	10.203	10.558	10.813	10.907
5.148	8.329	8.349	8.410	8.513	8.659	8.852	9.095	9.401	9.776	10.194	10.583	10.856	10.955
5.156	7.942	7.962	8.020	8.121	8.265	8.459	8.713	9.040	9.444	9.887	10.287	10.560	10.656
5.164	7.739	7.758	7.818	7.920	8.069	8.274	8.547	8.907	9.347	9.818	10.226	10.492	10.583
5.172	7.659	7.678	7.739	7.844	7.999	8.217	8.514	8.905	9.372	9.851	10.244	10.488	10.569
5.181	7.609	7.629	7.692	7.801	7.965	8.199	8.520	8.936	9.417	9.885	10.245	10.457	10.526
5.189	7.593	7.614	7.679	7.793	7.967	8.216	8.557	8.988	9.463	9.897	10.210	10.388	10.444
5.198	7.610	7.631	7.698	7.817	7.999	8.261	8.612	9.042	9.488	9.870	10.132	10.277	10.323
5.200	7.619	7.640	7.707	7.826	8.009	8.272	8.623	9.048	9.485	9.855	10.108	10.249	10.294

A E R O D Y N A M I C D A T A

F R E E S T R E A M C O N D I T I O N S

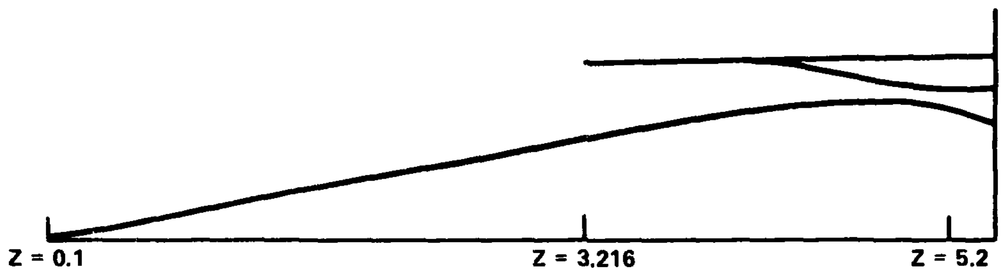
MACH NO. = 3.300000E+00 ANGLE OF ATTACK = 3.000000E+00 ANGLE OF SIDESLIP = 0.
VINF = 1.234747E+03 TOTAL ANGLE OF ATTACK = 3.000000E+00 AERO ROLL ANGLE = 0.
PINF = 1.000000E+00 DINF = 1.000000E-05 SINF = 0.
PERFECT GAS (GAMMA = 1.400000E+00)

R E F E R E N C E Q U A N T I T I E S

REFERENCE LENGTH IS 5.200000E+00 REFERENCE AREA IS 1.528185E+00 ZO IS 0.

FORCE AND MOMENT COEFFICIENTS

Z+ZO	CN	CA	CY	CMN	CMM	CML	XCPP	XCPY
5.112	8.50732E-02	4.01516E-01	0.	0.	4.26967E-02	0.	5.01882E-01	-R
5.119	8.22954E-02	3.98622E-01	0.	0.	4.00413E-02	0.	4.86555E-01	-R
5.126	7.98954E-02	3.95512E-01	0.	0.	3.77481E-02	0.	4.72469E-01	-R
5.133	7.82419E-02	3.92265E-01	0.	0.	3.61742E-02	0.	4.62338E-01	-R
5.141	7.75220E-02	3.88870E-01	0.	0.	3.55036E-02	0.	4.57981E-01	-R
5.148	7.77255E-02	3.85354E-01	0.	0.	3.57295E-02	0.	4.59688E-01	-R
5.156	7.85817E-02	3.81632E-01	0.	0.	3.65933E-02	0.	4.65672E-01	-R
5.164	7.97605E-02	3.77637E-01	0.	0.	3.77781E-02	0.	4.73644E-01	-R
5.172	8.10345E-02	3.73553E-01	0.	0.	3.90621E-02	0.	4.82043E-01	-R
5.181	8.22458E-02	3.69536E-01	0.	0.	4.02894E-02	0.	4.89866E-01	-R
5.189	8.32960E-02	3.65598E-01	0.	0.	4.13623E-02	0.	4.96570E-01	-R
5.198	8.41064E-02	3.61740E-01	0.	0.	4.22019E-02	0.	5.01768E-01	-R
5.200	8.42307E-02	3.60997E-01	0.	0.	4.23326E-02	0.	5.02579E-01	-R



$M_\infty = 3.5$ INLET CONTOUR DEFINITION

Z/r_a	r/r_a	$Z/r_a - .356$	r/r_a
Centerbody		Annulus	
0.0	0.0	2.86	1.0
4.0	0.70532	3.1	1.004188
4.1	0.7228	3.2	1.0054
4.2	0.7387	3.4	1.0051
4.3	0.7512	3.6	0.99996
4.4	0.759	3.8	0.9882
4.5	0.7625	4.0	0.9681
4.55	0.763	4.1	0.954
4.6	0.7625	4.2	0.9364
4.65	0.7611	4.25	0.9261
4.7	0.7585	4.3	0.9154
4.8	0.7504	4.4	0.8949
4.9	0.7391	4.5	0.8768
5.1	0.7120	4.55	0.8695
5.3	0.6829	4.6	0.864
5.5	0.6525	4.65	0.86
5.6	0.6362	4.7	0.8572
5.7	0.618	4.8	0.8533
5.8	0.5973	4.9	0.8511
5.9	0.5744	5.0	0.8502
6.0	0.5467	5.1	0.85
		5.6	0.85
		5.8	0.8574
		5.9	0.8646
		6.0	0.8735

Figure D-1. Inlet Configuration Geometry

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